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PUBLIC NOTICES.

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DEPARTMENTS.

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Professor D. R. HARTREE, M.A., Ph.D., F.R.S. (Applied Mathematics).
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Professor W. L. BRAGG, M.A., M.Sc., F.R.S., Nobel Laureate (Physics).
Professor F. C. THOMPSON, M.Sc., D.Met. (Metallurgy).
Professor W. J. PUGH, O.B.E., D.Sc., B.A. (Geology). 8850

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R. C. MOORE,
Director of Education.

Education Offices,
Guildhall, Hull.
July, 1932. 8828

Metropolitan Water Board.

TENDERS FOR THE MANUFACTURE, DELIVERY, ERECTION AND WORKING OF SEVEN ELECTRICALLY DRIVEN AND FOUR WATER TURBINE-DRIVEN VERTICAL CENTRIFUGAL WELL PUMPS, ONE 50 KILOWATT WATER TURBINE-DRIVEN GENERATOR AND APPURTENANT WORKS AT SURBITON PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY, ERECTION and WORKING of SEVEN ELECTRICALLY DRIVEN and FOUR WATER TURBINE-DRIVEN VERTICAL CENTRIFUGAL WELL PUMPS, and ONE 50 KILOWATT WATER TURBINE-DRIVEN GENERATOR, &c., at their Surbiton Pumping Station, Portsmouth-road, Surbiton, Surrey.

Forms of Tender, conditions of contract, specification and drawings may be inspected without charge at the Offices of the Board, Chief Engineer's Department (Room 173) on and after Monday, 15th August, 1932.

Contractors desirous of tendering may obtain the necessary documents from the Chief Engineer on production of an official receipt for the sum of Two Guineas, which must be deposited with the Accountant to the Board, and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings. Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 Noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes addressed to the Clerk of the Board and endorsed "Tender for Well Pumps, Surbiton," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Friday, 16th September, 1932.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
172, Rosebery-avenue,
E.C. 1.
8th August, 1932. 8852

The Trade Commissioner for MYSORE is prepared to receive TENDERS for the SUPPLY of METER-GAUGE LOCOMOTIVES, viz.:—

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The Engineer

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The Portsmouth Water Company.

An ENGINEERING ASSISTANT is REQUIRED by the above Company. Candidates should be about 25 years of age and have passed the Associate Membership Examination of the Institution of Civil Engineers (including Hydraulics) or other exempting Examination. Full training (both theoretical and practical) and subsequent first-class experience in waterworks design and construction essential. Knowledge of pumping machinery would also be advantageous. Commencing salary £350 per annum, rising by annual increments of £25 to £450, less 5 per cent. contribution to Superannuation Fund. The appointment is subject to satisfactory medical examination.

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MACHINE TOOL BUYERS GUIDE—ON REQUEST.

ALFRED HERBERT LTD. COVENTRY

A Seven-Day Journal

Opening of the Welland Canal.

MANY of the delegates to the Empire Conference at Ottawa were present last Saturday, August 6th, at the formal opening of the new Welland ship canal in Canada, by the Earl of Bessborough. This canal will form an important link in the development of the St. Lawrence River authorised by the recently completed St. Lawrence Waterway Treaty, details of which will be found in an article on another page of this issue. The Welland canal connects lakes Erie and Ontario, and is cut across the peninsula through which the Niagara River runs. The difference in level between the two lakes is 326ft. The first canal across the peninsula was constructed ninety-nine years ago, and since that date the continual increase in Canada's trade has caused improvements to be made at intervals. The present canal follows for the most part the course of an older one built in 1882, which has been improved and deepened. At the Lake Ontario end, however, a new cut has been made for about 12 miles. Its line is laid about 10 miles west of the Niagara River, and its length is about 25 miles. The lift of 326ft. is accomplished by seven locks, each raising the ship by 46½ft. They are 820ft. long and 80ft. in width, and the depth over the sill is 30ft. The canal itself provides a depth of only 25ft. at present, but the locks have been built with an eye to possible developments in the future. It is estimated that ships will pass through the canal from end to end in eight hours. This time is very considerably less than that necessary on the old canal.

Pooling Traffic on the Railways.

THE proposals of the London, Midland and Scottish and the London and North-Eastern railway companies to pool their competitive traffic were alluded to in a paragraph of our Seven-day Journal on June 3rd. Under the Railways Act, 1921, they had to be inquired into by a Committee appointed for the purpose by the Minister of Transport. The inquiry was begun on June 28th and was concluded on July 12th. On Friday, the 5th instant, the announcement was made by the Ministry of Transport that the scheme had been approved and that the report of the Committee would be available on Monday. That document—a Stationery Office publication, price 2s.—speaks of the scheme as "a plan which holds good promise of relief, temporary in any case, permanent it may be hoped. This relief is coming from the quarter from which relief comes best, namely, the exertions of the parties themselves and to these a pooling agreement must be a prelude." Mention is made of the fact, in relation to the opposition of the unions owing to the fear that men may be found redundant and be discharged, that every man is now secured of a job. The Committee did not feel justified in pressing the unions to accept the offer made by the companies, but it considered that the undertaking given was, in all the circumstances, a fair basis of settlement between the parties.

New Switchgear for Wolverhampton.

A PROPOSAL made at a recent meeting of the Electricity Committee of the Wolverhampton Corporation to spend over £77,000 on new switchgear to meet the conditions which will be imposed on the Wolverhampton system when it is connected to the "grid" led to a lively discussion. In presenting the report, Mr. H. Southan said that in view of the fact that the impending connection with the "grid" made the work necessary, the Committee felt that the entire cost should not fall on the department; but although both the West Midland Joint Electricity Authority and the Central Electricity Board had been approached with a view to getting some assistance, the request had been rejected. A letter had been received from the Home Office pointing out that the existing switches were inadequate to carry the load which might be put upon them in the near future, and it was considered essential to secure safety. There might be an explosion involving loss of life. Mr. J. Dallow, a member of the Electricity Committee, contended that the new switches were unnecessary. The Midland Power Company, he said, had the same switches as the Wolverhampton Corporation, and had decided to run the risk of keeping them. After further discussion, however, Mr. Southan explained that two-thirds of the present switches were about twenty years old. In some cases the rupturing capacity was 70,000 kVA, and in others 250,000 kVA. It was proposed to install new switches of 500,000 kVA rupturing capacity and to use the old switches elsewhere. Both the Chief Engineer of the West Midlands Joint Electricity Authority and the Home Office had advised the Committee that the new switches were essential. Later, Mr. T. A. G. Margary, the electrical engineer, explained the position in detail, and after several speakers had expressed their views as to where the contract should be placed, the Committee's recommendation and report were approved without a division. The report intimated that an expenditure of £60,975 was required on the Commercial-road switchboard, and £16,553 on switchgear reconstruction in sub-stations, and it was proposed that the main contract of £43,813 be given to the General Electric Company, Ltd., for the supply of a thirty-seven panel, 500,000 kVA rupturing capacity switchboard, complete with control board.

Empire Fibres for Rope Manufacture.

FOR many years past the ropes used by sea-going vessels have been made largely of the fibre known as Manila hemp. Much of this fibre could be replaced by Empire-grown fibres, such as Sisal hemp and New Zealand hemp, if they should prove suitable for use in this way. During recent years the production of Sisal hemp has undergone great development in British countries, especially in Kenya and the Mandated Territory of Tanganyika, and its employment for marine ropes would provide an outlet for the large quantities produced. Some years ago, when the question of the utilisation of the fibre for this purpose was under consideration at the Imperial Institute, it was found that there was an impression prevalent that Sisal hemp was unable to withstand the action of sea-water, and rapidly suffered a loss of strength. A series of trials has, therefore, been carried out by the Imperial Institute during the last six years in order to study the durability of Sisal hemp and New Zealand hemp in comparison with Manila hemp. A number of ropes of Manila hemp, Sisal hemp and New Zealand hemp respectively were made according to the same specification and were exposed to the action of sea-water, under precisely the same conditions, by placing them in wooden crates fixed to Southend pier in such a position that during each tide they were completely submerged for a period and completely uncovered for a period. The strength of the ropes was determined before immersion and after definite periods of exposure to the sea-water. The Imperial Institute has now completed the fourth series of tests carried out on these lines, and the results are recorded in a report published during the last seven days in the *Bulletin of the Imperial Institute*. They corroborate those of the earlier series in demonstrating that ropes composed of Sisal hemp or New Zealand hemp resemble Manila hemp ropes in their resistance to sea-water, and are capable of maintaining their strength to a similar extent. The loss of strength is at first more rapid than that of Manila ropes but subsequently less rapid, so that at the end of the period represented by four months' exposure little difference exists. It is also interesting to note that further exposure gives results in favour of the Sisal hemp rather than of the Manila.

Davey, Paxman and Co., Ltd.

IN our issue of May 27th last we announced that a new company was being formed with the object of acquiring and carrying on the business of Davey, Paxman and Co., Ltd., of Colchester, which would be entirely independent of Agricultural and General Engineers, Ltd. We are now in a position to state that the new company has been incorporated under the name of Davey, Paxman and Co. (Colchester), Ltd., the directors being the Viscount Goschen, Mr. P. A. Sanders, Mr. E. P. Paxman, Mr. F. Jarrett, and Mr. J. D. Dean. The active management of the business will be in the hands of Mr. P. A. Sanders, M.I. Mech. E., and Mr. E. P. Paxman, M.A., who were for long associated with the old company. The firm was established in 1865, and has had an honoured history in the production of boilers and steam engines, hydraulic plant and asphalt road plant. More recently it has achieved successes in the application of oil engines for power generation, transport and marine service. The new firm will, we are informed, shortly begin the production of certain other types of machinery, which, before the introduction of tariffs, were manufactured abroad. The head office of the company will continue to be at Standard Ironworks, Colchester, and its London office will remain at Aldwych House.

Industrial Lancashire.

ON Tuesday last, August 9th, there was issued a report of an Industrial Survey of Lancashire, which has been made for the Board of Trade by a number of investigators connected with the Departments of Economics, Commerce, and Administration in the University of Manchester. The report covers the largest of the five surveys made for the Board of Trade, and is a valuable study of industrial conditions in Lancashire. The area surveyed includes Lancashire south of Lancaster, excluding Merseyside and the Southport coast, but including North Cheshire and a part of Derbyshire. The population of the area is over 4,200,000, or 10·6 per cent. of the total in England and Wales, and it contains 1,488,000 persons insured under the Unemployment Insurance Acts. The year 1929 has been taken as a basis on which to estimate the surplus labour problem. Summing up the position in 1929, the report says that two-fifths of the surplus labour in the area can be attributed to increase in population and three-fifths to unemployment, which would have existed even if the industrial population had not increased. A return to 1929 levels of activity would still leave about 160,000 persons unabsorbed, not taking into account certain forms of unrecorded unemployment. Apart from industrial expansion beyond the 1929 level, a reduction in this surplus could only come through a fall in the numbers entering industry or the transfer of labour to other centres. Various suggestions as to making the areas under consideration more attractive to industrialists are put forward, some of which may prove to be successful.

The Science Museum Report.

IN the report of the Advisory Council of the Science Museum for the year 1931, just issued by the Board of Education, and signed by the new Chairman, Sir Richard T. Glazebrook, reference is made to the great loss sustained by the Council by the death of its first Chairman, the late Sir Hugh Bell, Bart., who did so much for the Museum and its work. The report states that during the year the Council has been made more fully representative of scientific and technical institutions and industrial groups, and that its new terms of reference now give it a more active part in the management and development of the Museum. A standing committee has been appointed from the Members of Council in order to prepare questions of importance for its consideration, and sub-committees have also been appointed to report on the Science Library and its working, a scheme of development for the Electrical Engineering Collection, and an exhibit to illustrate the physical aspects of pottery and porcelain manufacture. In this, the first report since its complete reorganisation, the Council places on record its high appreciation of the services of the Director, Sir Henry Lyons, F.R.S., who by his efforts and enthusiasm has seized every opportunity of increasing the usefulness of the Museum, and has been so closely associated with the magnificent growth of the Museum since the war. The report deals in detail with the various divisions of the collection, and we are interested and pleased to note that the attendance is still increasing.

The Leiston Works.

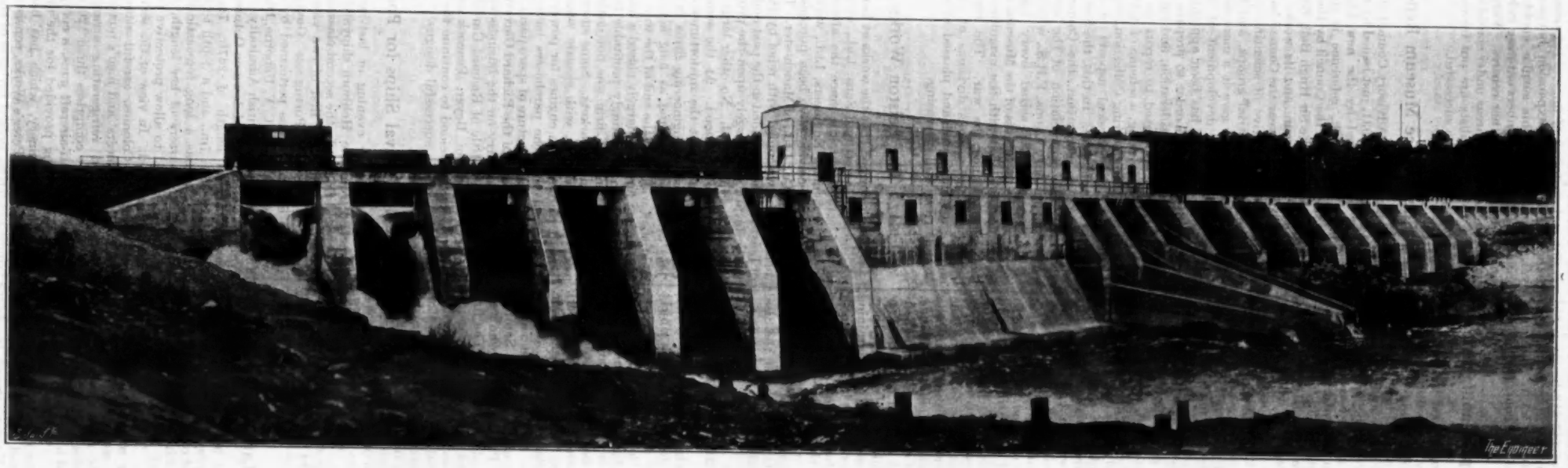
WE are informed that the works at Leiston, Suffolk, of Richard Garrett and Sons, Ltd., which have been almost completely idle since the affairs of Agricultural and General Engineers, Ltd., were put into the hands of a receiver, have been purchased by Beyer, Peacock and Co., Ltd., of Manchester. The announcement will be welcomed with relief by the inhabitants of Leiston, who depended in the past and must depend in the future very largely upon the prosperity of the works for a livelihood. No other large firm exists in the near neighbourhood. At the same time, great regret will be felt at the misfortunes of one of the oldest established engineering firms in this country. The works were started as long ago as 1778, and flourished well until the end of the war. The Russian revolution, however, largely closed a market that had formerly been exceedingly profitable for agricultural machinery, and the firm was not entirely successful in obtaining new markets. Some success was gained with steam wagons, with electric wagons, and with semi-portable steam engines for power stations. We understand that the purchasers have already commenced the manufacture of spare parts, which are now available for any of the Richard Garrett products. It is proposed to carry on the business of general engineers under the title of Richard Garrett Engineering Works, branch of Beyer, Peacock and Co., Ltd., and it may be decided to continue the production of some of the more successful designs.

New Naval Ships for Portugal.

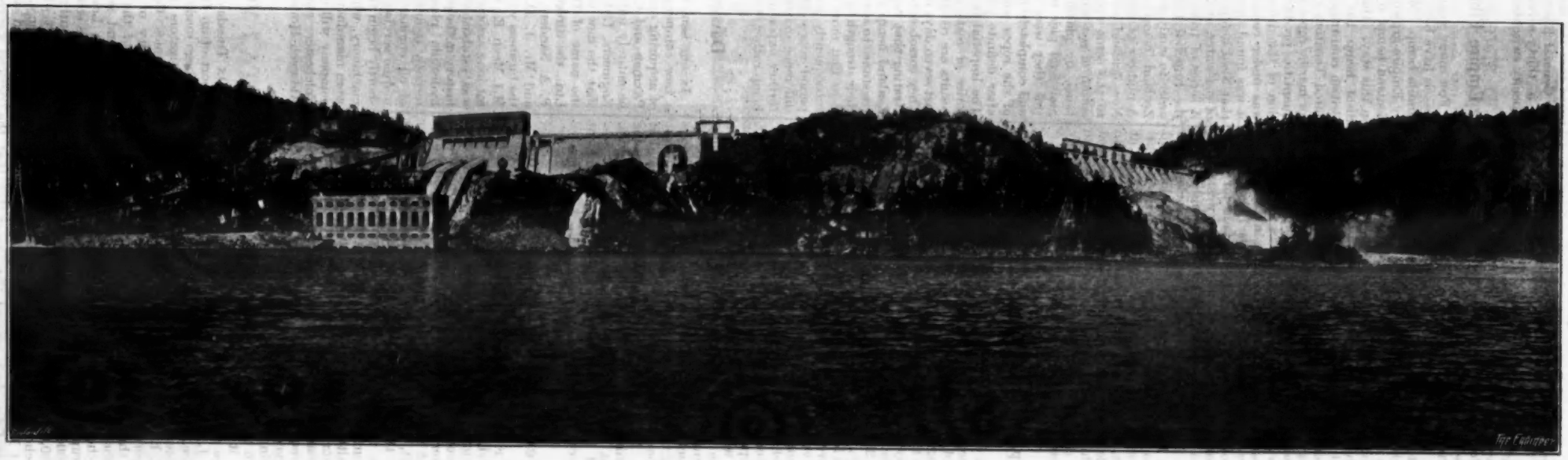
ON Wednesday evening of last week there was launched from the Hebburn shipyard of Hawthorn, Leslie and Co., Ltd., the second-class sloop "Gonçalo Velho," which is the first of two vessels under construction for the Portuguese Government. The naming ceremony was performed by Mrs. Usborne, wife of Rear-Admiral C. V. Usborne, Director of Naval Intelligence at the British Admiralty. The "Gonçalo Velho," which was laid down on October 9th last year, has an overall length of 267ft. 7in., an extreme breadth of 35ft. 7in., and a depth to the upper deck of 17ft. She has a long forecastle deck extending about three-quarters of her length, and the raked stem is designed to allow protective paravanes to be fitted if required. In view of the service of the ship in Portuguese Colonies, careful attention has been paid to both officers' and men's quarters, and to the ventilating and refrigerating arrangements. The main armament comprises three 120 mm. guns, and two 40 mm. anti-aircraft guns, a complete system of fire control being provided for the armament. The propelling machinery, which has been constructed at the firm's St. Peter's Works, consists of twin-screw, single-reduction, geared turbines of the Parsons type, with a designed trial output of 2000 shaft horse-power, corresponding to a speed of 16½ knots. Steam will be supplied from two water-tube oil-fired boilers of the three-drum Yarrow type.

HYDRO-ELECTRIC WORKS ON THE LIEVRE RIVER, PROVINCE OF QUEBEC

(For description see opposite page).



STORAGE DAM AT CEDAR RAPIDS



THE DAMS AND POWER-HOUSE AT HIGH FALLS

Harnessing the Lievre River, Quebec.

One of the most ambitious schemes of industrial development undertaken in Canada in recent years is being carried out on the Lievre River, in the province of Quebec, by the Maclaren-Quebec Power Company. It consists of a reservoir dam at Cedar Rapids, an 86,000 H.P. hydro-electric development at High Falls, recently completed, and a 130,000 H.P. hydro-electric station at Masson Falls, at the mouth of the Lievre River. The Lievre River flows from the north into the Ottawa River, at a point about 14 miles east of the City of Ottawa. It has its source in the Laurentian Mountains, in the same general vicinity as the headwaters of the St. Maurice and the Gatineau Rivers, and flows in a general southerly direction. The upper reaches of the river are situated in a rough, mountainous region, which is well forested. Tributary to the upper river valley are many lakes, which, together with the character of the topography, provide much natural storage. The Lievre has a drainage area above Masson of approximately 3615 miles. High Falls and Cedar Rapids respectively receive the drainage from about 3350 and 2890 square miles of territory.

In the year 1928 the James Maclaren Company undertook the construction of a paper mill at Masson to have a daily capacity of 250 tons of newsprint. The development of the High Falls power site was begun at the same time, in order to supply the paper mill with power for general purposes, and with the object of selling power should a future demand arise. It was decided to install 60-cycle electrical equipment at High Falls, since the general demand in the immediate neighbourhood was for current of that frequency. In order to utilise the High Falls power until such time as it could be sold, an electrical steam generating station was installed to produce process steam for the paper mill. Later, when the High Falls plant was completed, a contract was made calling for the sale of 25-cycle current to the Ontario Hydro-Electric Commission. Since High Falls had already been developed as a 60-cycle plant, it was decided to proceed with the construction of a 25-cycle plant at Masson to produce power for fulfilling the contract with the Ontario Hydro-Electric Commission.

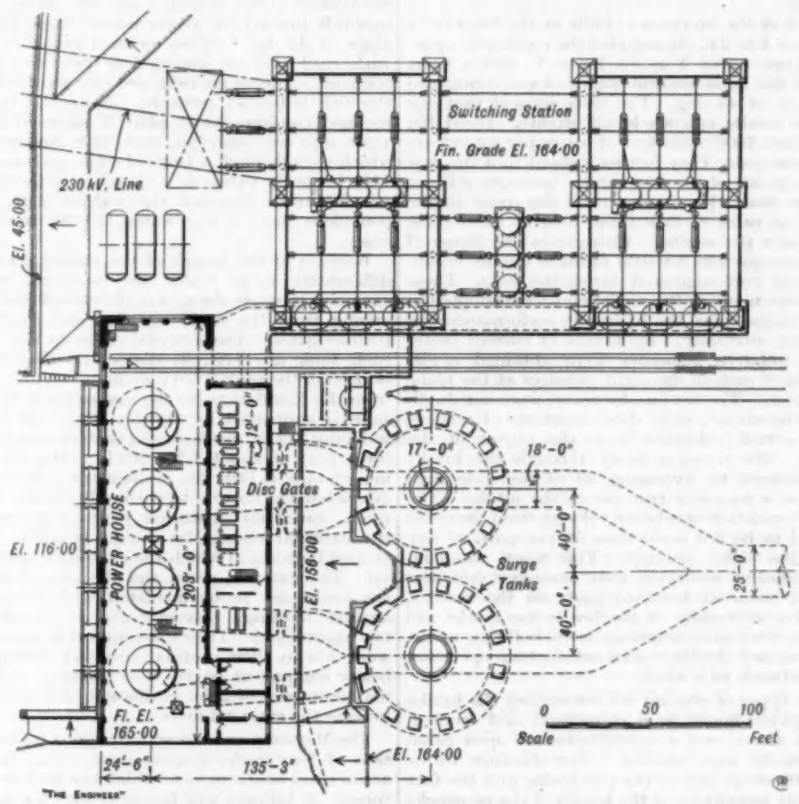
As part of the plan for developing the High Falls and Masson power sites, a storage dam was planned at Cedar Rapids for the purpose of regulating the flow of the Lievre River. A view of this dam is reproduced on page 150. Although the dam was designed so that the water level might eventually be raised to elevation 562·50, the reservoir will be maintained for the present at elevation 559·50, at which height the storage capacity will be 24·4 billion cubic feet. The site chosen for the dam was in a narrow channel with fairly flat banks. The section of the dam is of the gravity type. Its length is 755ft. between the abutments and its height, where the foundation is deepest, is about 85ft. from bedrock to the floor of the bridge which crosses the dam. The dam includes a sluice gate section containing four 8ft. by 8ft. gates for regulating the discharge; a log sluice section, containing three gates each 10ft. wide, the sills of which are 15ft., 22ft., and 29ft. respectively below extreme high water level; a Stoney gate section, containing eight gates, 24ft. wide by 20ft. high; and a stop-log section, having six bays, 17ft. wide by 15ft. high. The remainder of the structure consists of a gravity type, non-spilling section. A concrete gate-house encloses the hoists for the flow-regulating and log-sluice gates.

Because of the distance of the site from established transportation facilities, it was arranged to have most of the construction plant and materials brought to the site during the winter of 1928–29. The nearest railway station is at Gracefield on a branch of the Canadian Pacific Railway, which runs from Ottawa to Maniwaki. The highway between the site of the dam and Gracefield was improved for heavy winter travel, and most of the materials and construction plant were hauled to the site before the spring of 1929. The hauling was done principally with tractors and sleds, although horses supplemented the mechanical equipment. The length of the haul was about 25 miles. Fine and coarse concrete aggregates were found within a short distance of the dam. Many miles of new roads and bridges had to be built to replace those to be flooded by the water in the new reservoir. It was necessary to construct a rock-filled dam at Lake Cauchon and an earth-filled dam at Lake Campion to prevent overflow into the Gatineau River watershed. Both of these dams were built according to the designs and specifications of the Quebec Streams Commission. The Cedar Rapids storage dam was built under the supervision of the Quebec Streams Commission, which now owns and operates it.

High Falls Development.

A natural power site existed at High Falls, where an abrupt fall in the river made possible a compact development. At the head of the falls an island divided the river into what were known as the north and south channels. The presence of this island facilitated unwatering the bed of the stream for construction purposes, since each channel could be unwatered separately by means of an upstream coffer-dam built from the shore to the island, and allowing the water to pass through the other channel. A dam had been built at High Falls about twenty years ago for improving log-driving conditions on the river. On account of the greatly increased height to which it was intended to raise the water level for power development purposes, it was decided to demolish the old dam and build anew from the bedrock. A view of the High Falls development is reproduced on page 150. As at Cedar Rapids, all materials, except lumber and concrete aggregates, had to be transported about 25 miles from the nearest railway. In this case, however, materials were loaded on scows at Buckingham, and towed up the river, which is navigable to within a short distance of the power-house site. From the scow landing, a construction railway was run to the power-house, which was situated at the foot of the falls below the south channel with a branch up the hill to the dam.

The north channel dam has a gravity section, and is designed to pass large amounts of water during flood times. It contains eleven Stoney gates, 24ft. wide by 20ft. 6in. high, and a trash gate, 12ft. wide by 6ft. 6in. high. The length of this dam is 375ft. between abutments. A gravity dam and an intake structure were built in the south channel. The dam contains two waste gates, 18ft. wide by 13ft. 6in. high, and an ice sluice, 18ft. wide by 6ft. 6in. high. The remainder of the dam was constructed of an abutment type, non-spilling gravity section. The flood discharge capacity of the dam is about 65,000 cubic feet per second. The intake structure for supplying water to the penstocks has four intake gates of the Stoney type, 21ft. wide by 17ft. high, and operated by a 30-ton electric crane. Emergency gates of steel construction are provided to give access to the intake gates and to the screens in case repairs are necessary. The intake structure is covered with a building having a steel framework and brick walls.



THE MASSON POWER-HOUSE AND SWITCHING STATION

The power-house is situated at the foot of the falls below the south channel intake structure. Three steel plate penstocks, 14ft. in diameter, conduct the water from the intake to the turbines. The penstocks are anchored to the ledge of rock at intervals, and are enclosed with a protective covering of concrete, having a minimum thickness of 2ft. Individual tunnels were considered instead of penstocks, but it was decided that the extra cost of constructing them would not be warranted, and that with concrete-protected penstocks the permanence of the installation would be assured. The power-house foundations are on the solid ledge and contain the draught tubes for four vertical hydraulic turbines, three of which are now installed. These turbines were built in Canada by the S. Morgan Smith-Inglis Company, and are rated at 30,000 H.P. at full gate opening when operating under an effective head of 180ft. at 180 revolutions per minute. Three vertical three-phase, 60-cycle alternators are connected directly to the turbines. These alternators are rated at 25,000 kVA at 85 per cent. power factor, and generate current at 13,200 volts. Provision has been made in the power-house as well as in the intake structure for the installation of a fourth unit The generator-room contains an electrically operated 150-ton crane for handling the turbine and generator parts.

The transformers are situated in concrete compartments on the generator-room floor level upstream from the units. There are seven 16,667-kVA, single-phase, 60-cycle, oil-immersed, water-cooled transformers, which step up the current from 13,200 volts to 110,000 volts. The transformers are arranged in two banks of three each, with the seventh transformer serving as a spare for either bank. High-tension switching apparatus of the indoor type is provided on the floor above the transformers and lightning arresters for protecting the indoor equipment are placed on the generator room roof. The building superstructure has a frame of structural steel, brick walls, and concrete floors. Comparatively little tail race excavation was necessary to provide a free discharge for the water from the draught tubes.

An 110,000-volt transmission line delivers the current from High Falls to a substation at the Masson paper mill. The line is about 25·5 miles in length and consists of two circuits of three 397,500 circular mils steel reinforced aluminium conductors, and two 159,000 circular mils steel reinforced aluminium ground cables. Steel towers spaced about 700ft. apart support the conductors.

A log sluice gate at the south end of the intake structure empties into a steel plate log sluice, which runs down the hillside and discharges into the river a short distance below the power plant. Since the High Falls plant has a poundage of considerable size, amounting to an area of about 264,000,000 square feet, it will be possible to operate it as a peak load plant at low load factor. The construction of the High Falls development began in October, 1928, and current was transmitted to the Masson sub-station in August, 1930.

Masson Hydro-Electric Development.

The construction of the hydro-electric development at Masson began early in 1931. The nature of the topography indicated that comparatively long conduits would be required for delivering water to the turbines if the total fall were to be developed in a single head, since the natural drop in the river occurred in a distance of more than a mile. In general, the dam was placed as far downstream as the topography of the shores permitted, and was designed so as to raise the water level above the dam to that of the tail water at the Buckingham power station, about 5 miles above Masson. The dam is situated about 6000ft from the power-house, and consists of a gravity spillway section, 78ft. 6in. long, with its crest 4ft. above the average head water. It has eight flood control gates, 24ft. wide by 20ft. 6in. high, operated by a travelling gantry crane, two waste gates, 18ft. wide by 14ft. high, and a trash sluice gate, 6ft. wide by 10ft. high. The main dam is 428ft. 6in. long from the west abutment to the west end of the intake structure. The downstream wing wall of the west abutment is designed to include a log sluice. The calculated flood discharge capacity of the dam and gates is about 88,000 second-feet when the head water is at elevation 334·0.

The hydro-electric plant at Masson will require 7200 cubic feet of water per second when operating at its full capacity. The intake structure is at the east end of the dam near the shore line, and is designed

with a gravity section. The structure is 176ft. long, and is divided into eight inlet openings, 16ft. long by 22ft. high, which are provided with gates, screens, and emergency gates. A 50-ton electrically operated bridge crane will be used to raise and lower the gates and screens. Each pair of the eight gates opens into one of four closed passages, which gradually change in section from a rectangle to a circle with a diameter of 14ft. Each outside passage joins an adjacent interior passage forming a symmetrical "Y," the stem of which is 18ft. in diameter. The two 18ft. diameter passages join and form another symmetrical "Y," the stem of which is 25ft. in diameter, the size of the conduit to the power-house. The end passages are arranged symmetrically with the adjacent interior passages at points of relatively high velocities. The only unsymmetrical portions are just inside the gates where the velocities are relatively low.

The intake was required to deliver 7200 cubic feet of water per second to the tunnel at the maximum rate, and in so doing to increase the velocity from about 2·5ft. to almost 15ft. per second in a comparatively short distance. Since the design proposed represented a departure from ordinary practice, it was decided to have a model test of the intake made at the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute, at Worcester, Massachusetts, U.S.A., under the direction of Professor C. M. Allen. The object of the test was to determine the loss of head in the intake, the relative rate of flow through the eight gate openings, and the variation in the rate of flow in any one gate opening from the average flow through the intake as a whole.

A model of the intake was built in the laboratory to a scale of 1 to 24. It included the eight gate openings, the two upper Y's, the lower Y, and a short section of the main conduit which slopes downward at an angle of 45 deg. The tests showed that the loss in the intake as a whole will slightly exceed 1ft. of head when 7500 cubic feet of water per second are being discharged. They further showed that the flow through any one of the four intake passages will not vary more than 1½ per cent. from the mean intake discharge at rates of flow from 7000 to 9000 cubic feet of water per second. Changes in the shape of the end passages which would result in a more economical design were suggested during the tests. These changes were made in the model and were adopted in the final design, since the hydraulic performance was not affected adversely. By means of current meter traverses, relative velocities were obtained across the section of each of the eight passages at the plane of the screens. The screens, however, were not duplicated in the model, since determinations of relative and not actual velocities were the object of the traverses. The mean velocity through the intake was determined by averaging all of the individual readings in a complete traverse of the intake. The maximum variation of relative velocity from the mean was found to be not more than 50 per cent. at any point in the eight openings. This result was considered sufficient assurance that excessive velocities would not occur at localised spots on the screens. The relative uniformity of the flow in the intake will tend to prevent accumulations from building up on the screens, and should ensure satisfactory operation of the headwork as a whole.

Various types of conduit for connecting the intake and the power-house were considered and studied. Penstocks alone, and a combination of open canal and penstocks were studied. The distance to be covered, the large size of the penstocks, and the fact that a great proportion of the length of the penstocks would be subjected to high pressures, implied that any scheme for surface conduits would be very expensive. When the construction of a single tunnel through the solid rock was investigated, it proved to be less costly than any of the several surface conduits which had been considered, and offered a greater degree of permanence and reliability. The decision to construct a tunnel was made only after the depth of the surface of the bedrock had been determined, as well as the characteristics of the rock. For the purpose of defining the bedrock surface quickly between the proposed dam site and power station, Schlumberger electrical prospecting methods were employed to explore the east bank of the river over an area about 5600ft. in length and 800ft. in width. This work was done during the last quarter of 1929. From the results of the electrical survey, a contour map of the surface of the bedrock was prepared. It was then possible to locate the line of the tunnel definitely, with the assurance that it would traverse solid rock for its entire length. In order to determine the character of the bedrock along the line of the tunnel, diamond core drillings were made about 250ft. apart on the line of the tunnel, each hole extending to the invert of the tunnel as planned. The drillings indicated rock of such a nature that a tunnel could safely be driven through it. The drillings further served to check the bedrock contours which had previously been established by electrical prospecting. The agreement in contours as established by the two independent methods was remarkably close. Samples of the rock cores from the drillings were submitted to a mineralogist for inspection, and were reported to be satisfactory for crushing for coarse concrete aggregate.

A circular tunnel section, 25ft. in diameter, was adopted for hydraulic and structural reasons, even although it was estimated that it would cost slightly more than a horseshoe section of equivalent area. The water velocity in the tunnel when 7200 cubic feet of water per second are being discharged, will be 14·7ft. per second. The tunnel will be lined with concrete, nominally 22in. thick, with a minimum thickness of 15in. at small projections in the rock. No reinforcement will be necessary in the main tunnel, since the weight of the rock above the horizontal axis of the section is sufficient to overbalance the water pressure within the conduit. The tunnel slopes downward from the intake at an angle of 45 deg. to approximately the centre line elevation at 152. Here the direction changes, and having turned through a vertical curve, the tunnel extends a distance of about 5600ft. on a downward gradient of 3 per cent. At the low point of the tunnel near the power-house end, a permanent concrete-lined shaft has been provided. This shaft is off the centre line of the tunnel. Pumps and the necessary connections for emptying the tunnel will be situated in this shaft, and will be of sufficient capacity to pump out in thirty-six hours all the water which cannot be drained through the turbines. There will also be facilities for access to the tunnel from the permanent shaft for inspection purposes and for cleaning out sediment or foreign material which may gather at the low point of the tunnel.

Beyond the permanent shaft, the tunnel, as shown in the accompanying plan of the Masson power-house and switching station, divides into two branches, 18ft. in diameter, each at a horizontal angle of 45 deg. to the axis of the main tunnel. At points at which the centres of the branches are 80ft. apart they turn upwards toward the power-house through a vertical angle of 45 deg. These inclined branches are lined with steel and are designed to take the full water pressure. Anchorage rings are also provided to resist the full bulkhead pressure. Near the top of the inclined conduits, steel plate Y-pieces divide them again into two branches, each 12ft. 9in. in diameter, which turn through a vertical angle and connect with 14ft. butterfly valves in a chamber at the rear of the power-house. Beyond the valves, 12ft. diameter penstocks deliver the water to the turbine scroll cases.

Because of the length of the tunnel, two Johnson differential surge tanks are provided to prevent excessive pressure changes in the tunnel and penstocks arising from the rapid opening and closing of the turbine gates. The external risers to the bottom of each tank are 17ft. in diameter. The cylindrical portion of the tank is 68ft. in diameter, and the height from the foundations to the roof eaves is 202ft. Each tank is supported by sixteen 16in. "H" columns, weighing 342 lb. per foot, and each column is designed for a load of about 1,250,000 lb. The interior riser in each tank is 14ft. 6in. in diameter and extends from 5ft. below the bottom to within 3ft. of the top of the tank. Since no expansion joints were provided in the external risers, the design provides for torus-shaped bottoms in which the expansion may be taken up. The external risers and the curved bottoms of the tanks are to be insulated with cork to guard against freezing. Structurally, the tanks present few innovations. Their chief appeal as an engineering work lies in their unusual size and correspondingly heavy component parts. For instance, rods up to a maximum size of 2¾in. in diameter are used for cross bracing the main columns.

The Masson power-house is designed for the installation of four hydro-electric units. The foundations are of mass concrete, into which are built the draught tubes. A tailrace will be excavated for a length of about 300ft., varying from 150ft. to 200ft. in width, through which the water will return to the Lievre River. The power-house will be 203ft. long and about 82ft. wide. The west end of the structure is arranged so that heavy equipment may be delivered on standard railway cars directly to the generator floor, where it may be unloaded and moved into place by means of a 170-ton electrically operated travelling crane. The four vertical hydraulic turbines are being manufactured by the Canadian Allis-Chalmers Company, Ltd., and are rated at 34,000 H.P. each when operating under an effective head of 185ft. at a speed of 166·7 revolutions per minute. Woodward governor actuators are to be used for the regulation of the turbines.

Four vertical alternators will be installed. They are being built by the Canadian Westinghouse Company, Ltd., and are rated at 28,000 kVA, when operating at 85 per cent. power factor with a speed of 166·7 revolutions per minute. The current generated will be three-phase, 25-cycle, and the voltage 13,200. Station service equipment will be installed for using three-phase, 60-cycle current, which can be delivered either from High Falls through the paper mill sub-station at Masson or from Buckingham. The more important station service equipment at the Masson station will be duplicated so that 25-cycle current may be used, should the 60-cycle current not be available. An outdoor high-tension switching station will be situated west of the power station. There will be two 25-cycle, 63,000-kVA banks of oil-immersed, water-cooled transformers, each consisting of three single-phase units. The low-tension side will be 13,200 volts and the high-tension side 230,000 volts. High-tension switches and oil circuit breakers are provided between the transformers and the outgoing line.

It is proposed to construct a single circuit 230,000-volt transmission line, consisting of three 795,000 circular mils steel reinforced aluminium conductors. This line will cross the Lievre and the Ottawa rivers, and will connect with the high-tension lines of the Ontario Hydro-Electric Commission in the province of Ontario. The Masson plant is scheduled to begin delivering 25-cycle current to the Ontario Commission's system in July, 1933. To ensure delivery of the full amount of 25-cycle current called for in the contract, at times when low water will not permit the Masson plant to carry the entire load, it is intended eventually to install frequency changers at Masson. These machines will permit the 60-cycle current to be brought from High Falls and converted to 25-cycle current, when it may be sent out to supplement the Masson current. Should the High Falls plant be idle and the Masson plant running, it will be possible to convert the 25-cycle into 60-cycle current, and supply the Masson and Buckingham mills.

The Economics of Urban Electric Railways.

By HENRY WATSON.

No. IV.*

NEW SURFACE RAILWAYS.

In previous articles the cost of operating electrified suburban railways has been estimated. We may here consider the total operating costs of an entirely new suburban electric railway, to be constructed in fairly open country in the neighbourhood of a large city. The type of service and magnitude of traffic required to make such a facility, constructed at present-day costs, an economic proposition, is worthy of calculation, as indicating the potentialities of opening out new districts around great cities.

The railway contemplated will be similar to those discussed previously, in that a double-track route, 20 miles long, will have stations at every 1¼ miles, the trains making 25 m.p.h., including intermediate stops. A line of this length might connect two large towns, or double back into a large city in the form of a loop.

Cost.—The writer is informed, by a first-class authority, that the cost of new surface railways, constructed in open country in the neighbourhood of London, and excluding exceptional engineering difficulties, trains, or sub-stations, is of the order of £200,000 per mile of route. High though this may appear, as compared with pre-war construction costs, averaging £50,000 per mile, it is a minimum. It may be noted, in passing, that the Wimbledon-Sutton line, 5 miles long, with five stations, twenty-four bridges, and a certain amount of heavy earthworks, was reported to have a cost a million pounds, and that arterial roads often cost £50,000 per mile to-day.

Service Proposed.—A good service is essential with costly modern railways. Our estimates provide, initially, for a 10-minute service during 6 rush hours, and a 15-minute one for 12 slack hours, as detailed in Table IX. With 12 minutes lay-over at each terminal, the round trip is 2 hours, the 20-mile run being covered in 48 minutes. This yields an average speed with lay-over, of 20 m.p.h. During rush hours, eight-coach, 800-seat trains are provided, these being halved during the midday. With suburban compartment coaches, seating six aside, this capacity is quite practicable, though with limited comfort.

Stock Required.—Twelve trains are required in operation to maintain a 10-minute service, so that fourteen complete, eight-coach trains will be kept in stock to cover defectives and overhauling. This

TABLE IX.—*Estimate of Cost of Operating a New Surface Electric Railway. Assumptions.*

Length of route, double track	20 miles
Service: 6 rush hours, 10 minutes, 8 coach, 800 seat trains; 12 slack hours, 15 minutes, 4 coach, 400 seat trains	
Average distance between stations	1·25 miles
Average speed, excluding lay-overs	25 m.p.h.
Average speed, including lay-overs	20 m.p.h.
Lay-over at each terminal	12 minutes
Round trip time with lay-overs	2 hours
Trains in service, rush hours	12
Trains in service, slack hours	8
Trains in stock (8 coach)	14
Spare stock over rush hour requirements	17 per cent.
Train-miles per weekday = 20[(6 × 12) + (12 × 8)]	3360
Train miles per Sunday = 20[(16 × 8)]	2560
Train-miles per year = (3360 × 313) + (2560 × 52)	1·18 million
Train-miles per train (8 coach) in stock per year	84,500
Proportion of total mileage run with 8 coaches	38 per cent.
Average number of coaches per train	5·52
Average number of seats per train	552
Seat miles per weekday	1·92 millions
Seat miles per year	654 millions
Weight of 8-coach train	260 tons
Weight of average train	180 tons
Current consumption at sub-station, direct current	80 watt-hours per ton-mile
Current consumption at sub-station	14·4 units per train-mile
Cost of construction, excluding rolling stock, sub-stations	£200,000 per mile of route
Cost of 8-coach trains	£28,000 each
Cost of all trains	£392,000 lot
Total capital cost, excluding sub-stations	£4,392,000
Cost of current at sub-station D.C. bus-bars	0·8d. per unit

* No. III. appeared August 5th.

results in an annual mileage of 84,500 per eight-coach set in stock, which is not excessive.

Other Values Used.—Table X. gives an estimate of total operating cost, and, as in previous estimates,

TABLE X.—*Estimate of Cost of Operating a New Surface Electric Railway.*

Item.		Pence per train-mile.	Pounds per mile per year.	Route expenses, £ p.m. p.a.	Train expenses, £ p.m. p.a.
1	Traffic :				
	Wages running trains	2·5	619	—	619
2	Wages at stations ..	7·5	1,857	1,857	—
3	Other traffic expenses	2·0	495	—	495
4	Current, D.C.	11·5	2,850	—	2,850
5	Maintenance :				
	Trains	5·0	1,238	—	1,238
6	Way and structures	8·0	1,980	990	990
7	Station expenses ..	2·0	495	495	—
8	General expenses and rates..	10·0	2,475	2,475	—
9	Working expenses ..	48·5	12,009	5,817	6,192
10	Interest and deprec.:				
	Construction	48·6	12,000	12,000	—
11	Trains	5·2	1,274	—	1,274
12	Total operating expenses	102·3	25,283	17,817	7,466

current is taken at 0·8d. per D.C. unit at the sub-station bus-bars. Interest is at 5 per cent., and depreciation is covered by a 1·5 per cent. (30 years) contribution on rolling stock, 2·8 per cent. (21 years) on electrical equipment, and 1 per cent. (37/40 years) on construction. Wages, repair expenses and general expenses bear some relation to those of actual electric railways, when compared in terms of pence per train-mile or pounds per vehicle or mile of route, as is most convenient. Reference should be made to the first article for further details of capital costs, current consumption, &c. Necessarily these estimates can be only of a tentative or approximate character, but their utility for our purpose will not be reduced by the scope for slight variations of values proposed. Table XI. gives details of the figures used in Table X.

TABLE XI.—*Details of Estimate in Table X.*

2 .. 17 stations at £40 per week each = 7·2d., say, 7·5d.
3 .. Includes guards and cleaning trains
4 .. 14·4 units at 0·8d. each
5 .. Equals £221 per coach in stock per year
6 .. Includes buildings, earthworks and track
7 .. Equals £580 per station per year
8 .. Equals approximately 10 per cent. of revenue
9 .. Excludes interest or depreciation (or complete renewals)
10 .. Equals 5 per cent. interest and 1 per cent. sinking fund on £4,000,000
11 .. Equals 5 per cent. interest and 1·5 per cent. sinking fund on £392,000

Working Expenses.—A total of 48·5d., per train-mile, is obtained as the cost of working the railway, before paying interest charges, or making any provision for depreciation—either by placing sums to

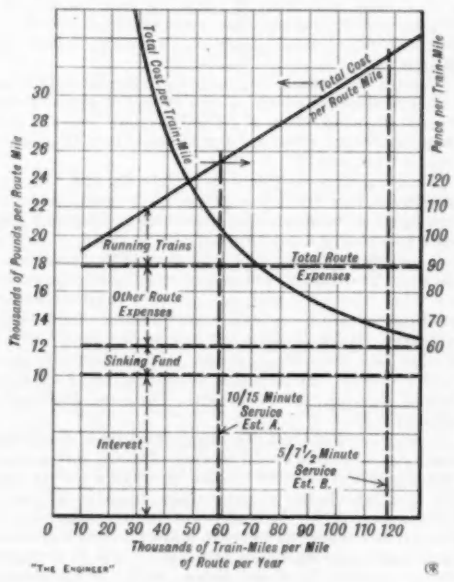


FIG. 6

the credit of depreciation funds or by undertaking complete renewals out of revenue. The costs incurred on the trains only amount to 21d.

Financial Charges.—Observe that at this service frequency the charges for interest at 5 per cent., and sinking fund at 1 per cent., on the construction cost absorb no less than 48·6d. per train-mile, leaving 5·2d. in respect of providing rolling stock to be met. The incidence of financial charges is clearly very heavy, and profoundly affects the cost of operating the trains.

Total Operating Cost.—A total revenue of 102·3d, per train-mile, or £25,300 per mile of route annually is demanded to make such a railway, providing a 10/15-minute service, a paying proposition to the extent of 5 per cent. average return on capital. Of the latter figure, £17,800 may be regarded as route expenses, *i.e.*, the cost of providing, maintaining and staffing the railway before any trains have been provided and commenced to run. No less than a third of the total operating expenses is accounted for by interest on the construction cost. Clearly, a service of less frequency to that postulated would be uneconomic, since so great an initial expense has already been incurred that the saving with a smaller service would not be worth while.

In order to appreciate the effect on operating costs of varying the service frequency, alternative estimates are shown in Table XII., alongside the above-

TABLE XII.—*Alternative Estimates of Operating Cost of New Surface Electric Railway.*

	A.	B.	C.	D.
Rush hour interval, minutes ..	10	5	10	7½
Slack hour interval, minutes..	15	7½	10	7½
Train-miles per year, millions	1·18	2·37	1·55	2·07
Average interval over 18-hour weekday	12·9	6·5	10	7·5
Seats per rush hour, each way	4,800	9,600	4,800	7,200
Traffic :	Pence per train mile.			
Wages running trains ..	2·5	2·5	2·5	2·5
Wages at stations	7·5	4·0	6·0	5·0
Other traffic expenses.. ..	2·0	2·0	1·5	1·5
Current, D.C.	11·5	11·0	10·7	10·0
Maintenance :				
Trains	5·0	5·0	4·5	4·5
Way and structures	8·0	5·0	6·5	5·5
Station and workshops expenses	2·0	1·5	2·0	1·5
General expenses and rates ..	10·0	6·0	7·5	8·0
Working expenses	48·5	37·0	41·2	38·5
Interest and depreciation :				
Construction	48·6	24·3	37·0	27·7
Trains	5·2	5·2	4·2	4·2
Total operating expenses ..	102·3	66·5	82·4	70·4
Annual revenue required, per mile	£25,300	£32,800	£26,600	£30,350
Revenue required per seat per mile	0·185d.	0·121d.	0·159d.	0·137d.
Average passenger flow required at 0·7d. per passenger per mile, per hour, each way	730	945	766	875
Maximum passenger flow at 5 times average, per hour, each way	3650	4725	3830	4375
Percentage of seats occupied in maximum hour	76%	50%	80%	61%
Passengers required per mile per year at 4d. each, millions	1·52	1·96	1·60	1·82
Proportion of seat miles to be sold	27%	17%	23%	20%
Seat miles provided per year, millions	654	1308	801	1066

described estimate, which is recapitulated in the first column. Estimate B provides for double the service. This costs only £7500 more, the cost per train-mile falling to 66·5d., and the annual revenue per route mile needed rising to £32,800. Estimates C and D provide for services of lesser magnitude, with a constant service interval throughout the day. The results are plotted in Fig. 6, in terms of both pence per train-mile and pounds per route mile.

We may draw a conclusion at this stage, and it is that a modern railway, costing £200,000 per mile, needs a traffic revenue of £25,000 to £30,000 annually per mile. If it is less than this, the costs per train-mile become excessive, and demand a high rate of fare, a poor midday service, congested rush-hour travelling or a low variation of maximum to average passenger flow. The average revenue, per train-mile, on the London Underground Railways is of the order of 70d., and this is not reached in our estimates until an annual revenue of £32,000, covering 110,000 train-miles, per mile of route per annum, is forthcoming. The higher the revenue per route mile, the lower the cost per train-mile, owing to the heavy fixed expenses.

Traffic Required.—A given revenue per route mile may be expressed in terms of passenger flow and average rate of fare per mile, or of passengers booking per mile and average fare paid.

An average passenger flow of 1000 per hour each way, for 18 hours and 330 days, at 1d. per mile, will yield £49,500 per year. Now, a suburban railway will rarely secure a higher rate of fare than 0·7d. per mile, bearing in mind the necessity of offering low season ticket rates for long distances if traffic is to be attracted to the line. Accordingly, an average flow of 730 per hour is demanded if we are to pay for a 10/15-minute service, costing £25,300 per mile.

If the average fare collected works out at 4d., then we require 1·52 million passengers to book for every mile of route annually. With stations 1¼ miles apart, 1·9 million passengers must book at each station on the average.

Loading of Trains.—We must consider the loading of the trains to verify the adequacy of the service contemplated. On suburban railways, even with good electric midday services, at cheap fares, it is not uncommon for the passenger flow in the busiest hour to reach five times the average over 18 hours. In good-class residential districts, with restricted road services, excellent routing and an attractive service, it may be less. Using this ratio, the maximum flow is 3650 passengers in one direction per hour. We are providing 4800 seats, so that 23 per cent. are vacant, and momentary fluctuations of up to 50 per cent. can be accommodated, with standing, without acute congestion of coaches resulting. Generally, the passenger loading tapers off from main terminals, and the service capacity must be graded to suit. The closer the steps fit the actual tapering the less the risk of congestion at any point. The average rate of fare, with this magnitude of service, will clearly pay for the provision of a fair and adequate service on this new railway. Each of the 654 million seat miles provided in a year (552 on every train-mile), must earn 0·185d.

Traffic Required in Terms of Population.—A given passenger traffic can be related to the population served by assuming values of annual revenue per head, derived from an assumed number of rides per head and average fare paid. In this way some more definite indication of the traffic requirements of a railway may be obtained.

Rides Per Head.—The population of a suburban residential district, outside a large city, well served by an electric railway, and utilising its services freely, may make 150 rides per head annually, that is, the total of all rides made on that line, divided by the total of population living close enough to it to use it freely for journeys to the principal destination.

Such a figure implies, roughly, a double journey every weekday by 1 in 4 of the population. If all the traffic comes from season ticket holders there will have to be, say, one to every household, reckoned as containing four individuals. Clearly, though such a figure can be exceeded, especially with heavy mid-day local riding, it implies very effective use of, and general dependence on, the railway for journeys for work, shopping, and pleasure. If there are local industries, absorbing local workers, or the population is of poor class, such a figure cannot be obtained.

Average Fare.—If the average length of ride is, say, 5½ miles, the average fare at 0·7d. per mile will come to 4d. One hundred and fifty rides per year at 4d. each means an annual revenue of 50s. per head of population served.

Our 20-mile railway, requiring an annual revenue of £506,000, must serve, definitely and effectively, a population of 200,000, distributed along a well-developed, residential belt, connecting towns or clustering around a large city. There are fifteen intermediate stations, and, if we suppose (1) that the two terminals are in the city itself, and (2) that two intermediate inner suburban stations are of little value to local residents, there must be a population of nearly 16,000 per station, paying £2 10s. per head for railway travel.

Expressed in another way, we shall require some 30 million passengers annually, or 2,300,000 to be dealt with at each of thirteen intermediate stations (booking and leaving), or 15 million booking at intermediate stations, and 15 million booking at the two terminals, supposing all traffic passes through a terminal, entering or departing.

These demands are very difficult to satisfy. We may say that new surface railways, as an aid to the development of new suburban districts, can be contemplated only where it is likely that great areas will open up, and yield populations of at least 10,000 per route mile, dependent on the railway for daily travel.

Further, this population must make journeys justifying a fare of 4d., so that, where distributed along the line of route, a length of railway of less than, say, 10 miles, and a population served of under 100,000 are not likely to provide the required revenue, for the average journey will then be too short and the dead route mileage, due to road facilities, too great a proportion of the whole.

Terminal Township.—So far we have regarded the population served as distributed along the railway in the form of a belt, the predominant traffic being to or from a city terminal to intermediate suburban stations. But the traffic on some short length railways, terminating in large suburban townships, with co-ordinated road services radiating therefrom, is predominantly terminal to terminal traffic, the booking at intermediate stations being of minor value. We may consider this type of line. A railway pushing out 4 miles into open country will require a revenue of £100,000 to £120,000 per year. If the intermediate district is not likely to yield much railway traffic—as being too well served by road transport or unsuitable for good-class residential development—the terminal to terminal traffic may aggregate 80 per cent. of the whole. Using the lower figure, we require the suburban town to provide at least £80,000 per year. An average fare of 3d. and 150 rides per head annually yields a revenue of 37s. 6d. per head. The population served must therefore attain to 43,000 as a very minimum. This must be exclusive of that absorbed by local activities. Indeed, essential local services may increase the population to 60,000, and reduce the ride demand to 107 per year; 6·4 million passengers will ride to or from the suburban terminal, plus a small number from intermediate stations. That is, some 6¾ million passengers may be dealt with at the suburban terminal annually and £85,000 will be collected there, if the receipts of all passengers passing through it are credited there, instead of being shared with the city terminal.

Our 4-mile railway must develop a township dependent on it of, say, 60,000 population within, say, five to six years of opening. With twelve persons per acre it will be just over 3 miles in diameter.

Effect of Heavy Traffic.—High density traffic permits a low fare rate for a given standard of service, because the cost per train-mile falls sharply with increasing frequency of service, and, moreover, it is

not essential to increase the midday frequency in proportion to the total traffic carried. Frequency, not loading, is then vital, and on dense traffic routes trains can be well loaded during the day, whilst being sufficiently frequent, thus yielding economy without discomfort.

This is demonstrated in the following tabular comparison of services designed to suit the traffic carried, the first column including the values obtained above.

	A.	B.	C.	D.	E.
Intensity of service	Low	Medium	High	Medium	Low
Average passenger flow	730	1460	1460	730	730
Maximum passenger flow	3650	7300	7300	3650	3650
Rush service interval (min.)	10	5	5	7½	10
Slack service interval (min.)	15	15	7½	7½	10
Seats per hour—rush	4800	9600	9600	7200	4800
Cost of service per mile	£25,300	£30,000	£32,800	£30,350	£26,600
Average rate of fare required	0·7d.	0·42d.	0·45d.	0·84d.	0·74d.
Average passengers per train in slack hours (40 per cent. carried then)	110	220	110	55	74

With double the traffic the fare can be 60 per cent., with the same slack hour service. A slight increase to 65 per cent. will provide for half the slack hour interval, *i.e.*, double the service all day long. The original traffic, with a 10-minute midday service, demands only 5 per cent. more revenue, whilst a 7½-minute interval all day, permitting more comfortable rush hour travelling as well, costs 20 per cent. more. The midday frequency, with heavy traffic, can be intensified, if need be, at a very slight extra cost, *i.e.*, to provide 7½-minute service, instead of a 15-minute one, costs 0·03d. to 0·14d. extra fare. A 50 per cent. increase in rush hour service costs only 8 per cent. more—compare estimates D and B. On costly railways there is little excuse for infrequent services, since the extra cost of better facilities is relatively so slight.

Conclusions.—A belt line railway needs a population of at least 10,000 per mile making 4d. journeys thereon. A connecting line 4 miles long must serve at least 60,000 of population utilising it freely. An average rate of fare of ¾d. to ½d. per mile is possible with heavy traffic.

(To be continued.)

Links in the History of the Locomotive.

By C. F. DENDY MARSHALL, M.A., M.I. Loco. E.

During the time which has elapsed since I last laid the results of my researches before the readers of The Engineer,* a considerable amount of further information has come to hand, which it is hoped will be found of interest.

Orrell Colliery.

Two letters were shown at the Liverpool Railway Centenary Exhibition, which have since been presented to the Wigan Public Library. They were written by Robert Daglish, sen., in 1856, and state that he built the three engines, two of which worked with a rack and the other with simple adhesion; the first having been made in 1812 and put "with full action" on the colliery railway at the beginning of 1813; the other two before the end of 1816; and that they were used for upwards of thirty-six years, until the colliery closed.

Orrell is about 3 miles west of Wigan, and the line ran from there about 2½ miles northward to the Leeds and Liverpool Canal. In my article above referred to I assumed that there was some connection with a Mr. Orrell, who opposed the Liverpool and Manchester Railway. This was a mistake.

Fig. 1—Oil Painting by J. E. Ferneley

Stephenson Engines.

An interesting vignette from a colliery map of the early ninteeenth century was reproduced and discussed in an article by Mr. Appleby Miller in The Engineer for September 18th, 1931. It shows a six-wheeled version of the "Blucher," driven by gears. It may represent that engine rebuilt, or a previously unrecorded one, constructed before the Stephenson-Dodd engine of March, 1815, in which gears were dispensed with. But it is by an unknown hand, and only intended as a picture and not a piece of history, and quite possibly the artist evolved it from memories of "Blucher," mixed up in his mind with the Stephenson-Losh engine of 1816, which had six wheels.

The Gloucester and Cheltenham "Royal William," which I credited to Stephenson in "Two Essays in Early Locomotive History," on the strength of a representation on a medal, was built at Neath Abbey, and will be mentioned again later on. This was a case of relying on an artistic representation, which has turned out to be purely fanciful.

The engine which I made out to be the seventeenth built by the firm of R. Stephenson and Co., and which Mr. Warren calls "Whistler's engine," was intended for the Baltimore and Ohio Railway, although no reference to it occurs in Mr. Hungerford's history of that line, published in 1928. The old ledger, to which I referred in my previous article, contains the following entry:—

Sept. 17th (1829).—Baltimore and Ohio R., 1 loco. engine on springs with 6 wheels £560. Freight to Liverpool per "Fraser" and exp. £21.10.0.

A rather obscure reference a little further on to underwriters made me wonder if anything happened to the "Fraser." Inquiries produced the following results:—

(1) Report from Lloyds:—

Peterhead, Sept. 28, 1829.—The "Fraser," Hindmarsh, from Newcastle to Liverpool, was wrecked this day on the South Head. The crew most miraculously saved by Capt. Manby's apparatus, under charge of the Coast Guard. She has steam machinery on board, which will most likely be saved.

A similar notice appeared in *The Times* for October 3rd.

(2) A much fuller account was given in the *Aberdeen Journal* for September 30th, 1829, as follows:—

Peterhead, September 28th, 1829.—This afternoon the sloop "Fraser," of Blythe, from Newcastle, bound for Liverpool, with valuable machinery on board, endeavouring to take the North Harbour of Peterhead, was unfortunately driven on the rocks near the entrance. It was then blowing a very severe gale from the N.W., and the sea was extremely heavy. In less than five minutes after she struck, her mast fell over her side, and the situation of the crew became extremely critical. The Coast Guard speedily repaired to the spot with Captain Manby's apparatus, and succeeded in getting a line thrown over the vessel. The Master and crew having fastened themselves to it, were pulled through the waves to the rocks, and were, fortunately, but little injured. Too much praise cannot be given to Lieutenant Sims, of the Coast Guard, and the men under his command, and, generally speaking, to the persons assembled on the shore, for the promptitude and alacrity with which they rendered assistance. The vessel is now a total wreck. Part of the materials of the cargo has been saved, under the direction of Lieutenant Sims and the Vice-Admiral Depute; and every exertion will be made by them to bring as much more into safety as possible.

No further reference to the matter can be found. Captain Manby's system was a predecessor of the rocket apparatus, in which a rope was shot across the vessel by means of a mortar.

There can be very little doubt that the engine is still there. And the chances are that it is close in shore, because an inquiry at the Newcastle Custom House has produced the amazing information that the "Fraser" was under 69 tons; length only 55ft. 10in. (smack-rigged), so that she probably drove quite close in. It seems extraordinary that anyone should have thought of sending a locomotive round the north of Scotland in such a cockleshell, and thirty years old, too. She was built at Laing's yard, Sunderland, in 1799.

There is an opportunity here for someone willing to go to the expense of hiring a diver to have some sport. If it could be recovered, I think the engine would be the property of the King, but have very little doubt that His Majesty would present it to the Science Museum.

Mather, Dixon and Co.

In an article in The Engineer for April 14th, 1899, which had escaped my notice when writing "Two Essays," it is stated that this firm built a small locomotive for its own use in February, 1827, with 3ft. wheels, coupled. They also built one named "Wigan"—their Number 22—for the Wigan and Parkside line, which is omitted from the notes on that railway in my "Centenary History of the Liverpool and Manchester Railway."

Neath Abbey Ironworks.

I am indebted to Mr. Glen A. Taylor, of Messrs. Taylor and Sons, the successors of the Neath Abbey Ironworks, for some most interesting and valuable information. Light is thrown on the curious engines mentioned on page 84 of "Two Essays," which were illustrated in *Engineering* for November 15th, 1867, and copied by Deghilage, of which there were four in all. The first one is a small four-wheeled engine, with vertical cylinders high up on the middle of the boiler, the piston-rods working upwards, attached to stirrup links which embrace the cylinders and drive the wheels through light bell cranks. This engine was named "Speedwell," and was supplied to Thomas Protheroe, and worked on the Sirhowy Railway. A drawing of the cylinder is dated December 22nd, 1829. It shows

Fig. 2—Russian Cast Bronze Plaque

a very early example of metallic packing for the pistons—which had also been used on the "Novelty." The feed water was heated by a jacket round the exhaust pipe.

We now come to an engine of extreme interest from a historical point of view, of which I reproduce the original drawing—Fig. 3. The "legend" says it is a "locomotive intended for the Dowlais Iron Company, August 31st, 1831."

If my opinion, as given in "Two Essays," on the subject of the Hedley engines, is correct, namely, that in their eight-wheeled state the trucks had only side-play, and did not rotate, this is the first engine with pivoted bogies, and the first articulated locomotive. This claim, of course, rests on the assumption that the above represents the date of actual building, a point on which at present there is no evidence. Horatio Allen's "South Carolina," which was on two swivelling bogies, was not put to work until February 24th, 1832, according to the "Centennial History of the South Carolina Railroad," Appendix II.

It will be seen that the engine had twin chimneys, side by side, which could be turned down into a horizontal position in order to pass through a low tunnel. The gear wheels are shown—diagrammatically—as if with square teeth. It is obvious that the edges would have to be curved, in order to allow the bogie to turn. Such teeth are shown in the last of the four Neath Abbey engines in *Engineering*, which is of similar design, but has an ordinary chimney at the opposite end to the cylinders. It was built for the Rhymney Ironworks in October, 1837.

I have now succeeded in running the Gloucester and Cheltenham "Royal William" to earth. The representation on the medal—shown in "Two Essays"—is a typical six-wheeled Stephenson engine, but it appears that the design was far more original, and, in fact, was one of the most interesting of the early locomotives. Mr. Taylor has a number of drawings of details of this engine, dated from June to December, 1831, but unfortunately no general arrangement one. But a drawing of the packing case in which it travelled has survived, with the outline of the engine indicated in broken lines, showing that it was six-coupled, with vertical cylinders situated over the centre pair of wheels, driving by means of a bell crank. It was not only remarkable for the unique "lay-out" of the machinery, but also for having a

* July 18th, 1930.

water-tube boiler. The railway company had evidently not been put off by their previous experiences—1825—with a M'Curdy boiler.

The next engine is the second in the *Engineering* and Deghilage set, which had horizontal cylinders at the top of the back of the boiler, driving a rocking lever, which was connected at the lower end to the rear pair of six coupled wheels. It was named "Industry," and was built for Ebbw Vale, the drawings being dated April and May, 1832.

The third engine given in the same article was six-coupled, with combined rack and adhesion working. No doubt the first of this kind. The cylinders were just behind the smoke-box, steeply inclined downwards, driving a dummy shaft behind the trailing wheels, which geared with the latter, also with a pinion still further aft, which could be raised or lowered for engagement with a rack. This engine was supplied to the Dowlais Ironworks, and named the "Perseverance." The *Cambrian Quarterly Magazine* for 1833, page 189, contains the following account of its performances :—

> The "Perseverance" engine, got up by the Neath Abbey Iron Company, South Wales, and supplied with the assistance of a rack running parallel with the tramplates from Penydarren to the Dowlais Works, has accomplished the amazing task of conveying from the Dowlais Works to the basin of Cardiff Canal, 126½ tons of iron at once, besides the weight of engine, tender and waggons 50¾ tons, making an aggregate of 177 tons. The engine, after waiting several hours for the discharge of the iron, returned to the works with her complement of empty waggons, and ascended the side of the mountain, by means of the rack, with ease, without stopping for steam. The fact is the more remarkable from the road winding in some places excessively . . . and for the first nine miles of the road from the basin having an ascent of from 1¾ to 7¼ inches in a chain, and the last two miles 25½ to 48¼ inches per chain.

The gradients given as 7¼in. and 48in. per chain are approximately 1 in 108 and 1 in 16¾.

The fourth engine of the set is the double-bogie Rhymney engine of 1837, which has already been mentioned. The article which accompanied the drawings, and bore the fanciful title "Pre-Adamite Locomotives," contained very little information about the engines, not all of that being accurate.

It is clear that for brilliant originality, the designer to the Neath Abbey Works, Henry Taylor, was second to none of the early engineers. This notice of his work may be fitly concluded by the following extract from the *South Wales Weekly Argus* for June 14th, 1830, which was copied from the *Monmouthshire Merlin* of June 12th, 1830 :—

> Arrangements have recently been made by the Monmouthshire Canal Co. for adapting their extensive lines of tramroad for the use of locomotive engines, which are likely to become general in that district. Mr. Prothero, one of the most extensive coal merchants in that district, intends hauling his coal to Newport with two engines, preparing for him at the Neath Abbey Iron Works, and Messrs. Brown, of the Blaina Iron Works, have nearly completed a locomotive engine for their own use embracing many improvements.

Even further possibilities are opened up by the above. One wonders what Messrs. Brown's engine was like !

One or two more modern items of considerable interest have been added to my collection, concerning which further information or suggestions will be very welcome.

The first is an oil painting by J. E. Ferneley, shown on the opposite page—Fig. 1.

Ferneley (1781–1860) was a sporting artist of considerable eminence, whose hunting and racing pictures now command high prices. This example represents the opening of some railway, with considerable festivities in progress, including, in the right foreground, the roasting of an ox whole. I shall be very grateful to anyone who can suggest what railway it is. The engine appears to be of Stephenson design, namely, a "Patentee." The date might be anything from 1835 to 1850. Both engine and carriages—the latter open—are either black or of some very dark colour. The cutting behind the train looks like chalk. No other hints suggest themselves, except the fact—for what it is worth—that Ferneley lived for many years at Melton Mowbray.

The next illustration—Fig. 2—shows a cast bronze plaque of Russian origin. The translation of the inscription is "From the Ministry of Ways of Communication."

The engine resembles almost exactly, even to the peculiar shape of the number plate, some locomotives built by Robert Stephenson and Co. from Kirtley designs for the Lyons and Mediterranean line in 1855, which were illustrated in the *Locomotive* for May, 1930. They were nearly identical with the Midland express engines built at Derby 1856 to 1861, shown in Ahrons' Fig. 134 ; but the Midlands did not have a bell mouth to the dome. I have been unable to discover whether any engines of this type were built for Russia. If so, it was not by Stephenson and Co. It is possible that the plaque was made by a French artist, who took as a model the first engine that came to hand. Some very similar engines, except for a roof over the footplate, were constructed by the above-mentioned firm for the Egyptian Railways in 1867, one of which was exhibited that year in Paris.

The last "link"—for the present—is a warning to be wary of information in official publications. Through the kindness of a friend, I have acquired an oblong folio volume, entitled "1873–1923. Ferrocarril Mexicano. Commemoracion del 50° Aniversario de la Inauguracion del Trafico Directo entre Mexico y Veracruz."

Among the numerous illustrations is one of a gaudy locomotive and state carriage combined, which is precisely like the "Saloon Locomotive for the Viceroy of Egypt, built by Robert Stephenson and Co., in 1862, and decorated to the designs of Digby Wyatt," illustrated in "A Century of Locomotive Building," on page 411, and described as above. The translation of the description in the Mexican book is as follows :—

> "Imperial" Engine and Coach (the carriage on the following page). The London firm that built them states that they were intended for the F.C.M. (Mexican Railway) though never reaching Mexico probably on account of the downfall of Maximilian. It appears that they were sent to the Exhibition at Paris, and their whereabouts forgotten.

Messrs. Stephenson and Co. are certain that the engine on page 411 of "A Century" is their No. 1295, and was built for Egypt in 1862. They have no record of a second engine of the kind being ordered for Mexico or anywhere else. Maximilian was shot in June, 1867, so that the engine, if it had ever existed, might quite well have been sent to the Paris Exhibition of that year ; but the volume of *Engineering* for 1867, which appears to describe all the locomotives at the Exhibition, does not mention it, and there is no doubt that the whole thing is a pure myth from beginning to end.

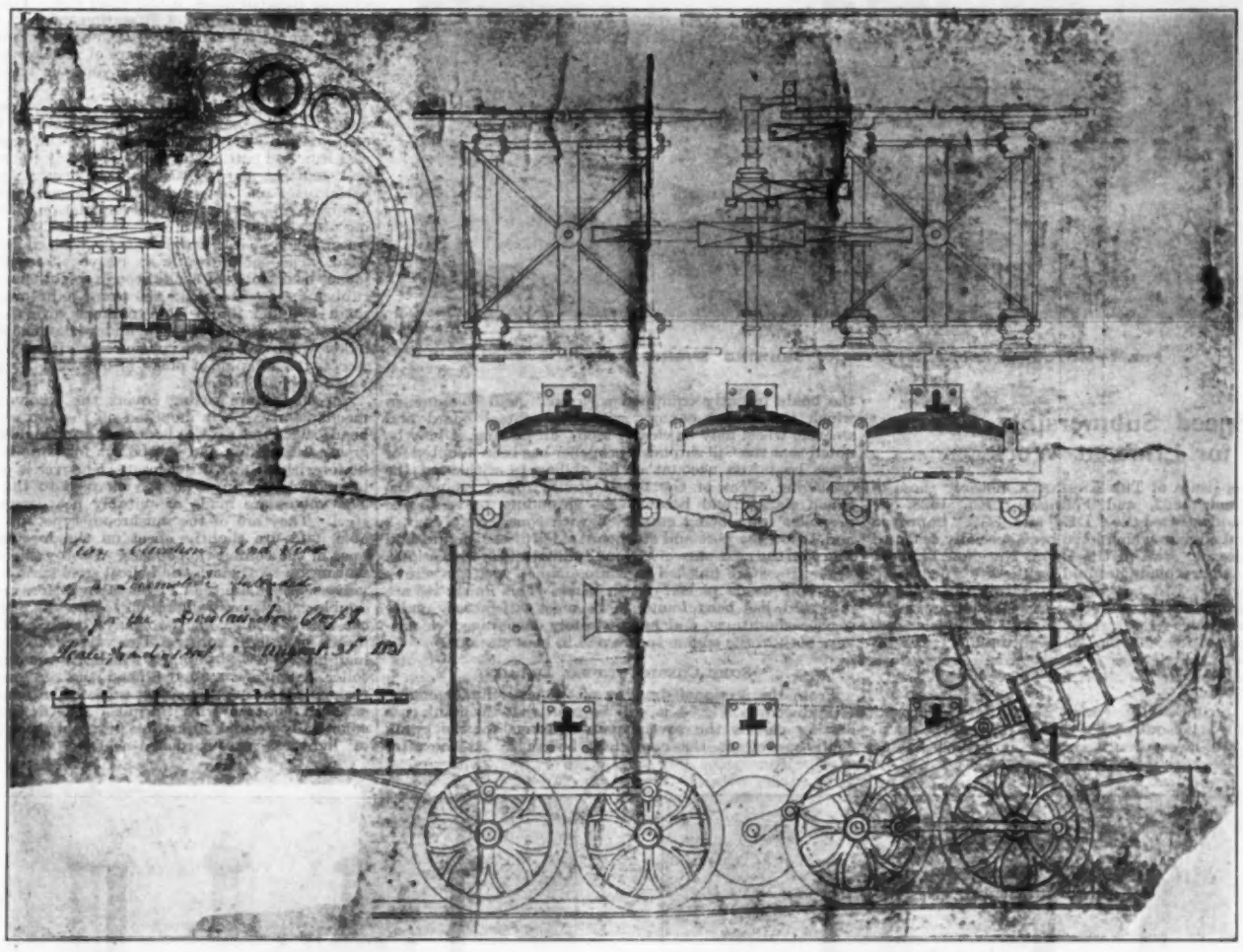


FIG. 3—"LOCOMOTIVE INTENDED FOR THE DOWLAIS IRON COMPANY,' AUGUST 31ST, 1831."

A NEW AMERICAN WATER-TUBE BOILER.

THE new Freeman boiler is designed to burn oil, natural gas or pulverised coal, but by the introduction of a bridge wall it can be adapted readily to stoker firing. At one side of the furnace space and parallel with it are two drums connected by vertical tubes, a partition wall between two rows of tubes separating the body of tubes from the furnace. From the side of each drum extend two sets of tubes, which reach across the furnace and down the outer wall, forming three sides of a rectangular space, with the vertical drum tubes as the fourth side. Fuel is blown into a brick ignition chamber, the gas and flame then passing through the rectangular space formed by the tubes beyond which is a combustion chamber, with ashpit. From this chamber the flame and gas return through the series of vertical tubes connecting the drums. In the combustion chamber and connected to the top drum is a superheater of U-shaped vertical tubes. Turbulence in the upper or main drum is restricted to the rear portion by a diaphragm at mid length, this diaphragm being slotted in the upper portion to permit the passage of steam and slotted in the lower portion to allow free circulation of the water. A baffle in front of each steam slot obstructs the flow of steam, causing it to precipitate its entrained moisture. Except in the ignition chamber, the walls, floor, and roof of the furnace are cooled, either by air or water. A pulveriser unit, placed in front of the boiler, is an integral part of the installation, as is also a revolving soot blower, which can reach all convection surfaces as well as the superheater tubes. A partition in the lower drum forces the feed water to rise through a certain group of tubes, and the vertical tubes at the forward ends form an economiser.

35 B.H.P. HIGH-SPEED SUBMERSIBLE LIFEBOAT ENGINE

THE WEYBURN ENGINEERING CO., LTD., ELSTEAD, SURREY, ENGINEERS

FIG. 1—MOTOR LIFEBOAT ON STOCKS SHOWING ENGINE CANOPY

High-Speed Submersible Engine for Lifeboat Work.

IN previous issues of THE ENGINEER, notably those of December 22nd, 1922, and February 17th, 1928, we described and illustrated the "DE" and "CE" improved types of petrol engines which have been specially designed by the engineering staff of the Royal National Lifeboat Institution, and are manufactured by the Weyburn Engineering Company, Ltd., of Elstead, Surrey, in order to meet the arduous duties of lifeboat service. A new series of engines of the "AE6" six-cylinder type, which are specially designed for 35ft. 6in. self-righting lifeboats, was put into service a little over a year ago, and is described in the following article.

OBJECTS OF DESIGN.

The design was got out with a view to putting the maximum power into the smallest possible space without having to sacrifice any of the trustworthiness and readiness for instant service which is a rigid necessity in a lifeboat engine. The question of weight was also very carefully considered, and it was sought to design an engine of which a complete overhaul could be made at the lifeboat station without the employment of lifting gear. It was further decided that the crank cases and attached components should be such that the engines could easily be handed for use either singly or in the twin-screw arrangement adopted for beach type lifeboats. As in the case of the "DE" engine, it was decided to carry the cowled crank case vents and carburetter air inlets to a height well above the submerged water line of a waterlogged boat. Provision was also made to ensure the automatic stopping of the engine, the cutting off of the fuel, the prevention of the loss of oil and circulating water, and entry of sea water into the exhaust system should a boat capsize. We shall refer to some of these special mechanisms later. The new engine has a capacity of 1½ litres, a designed output of 35 B.H.P. at 3300 r.p.m., and the cylinders are 2 $\frac{3}{16}$in. bore with a stroke of 3½in. The weight of the complete engine and reducing gear, which is used to lower the engine speed to 900 r.p.m. at the propeller, is 7 cwt.

Fig. 1, reproduced at the top of the page, shows one of the boats recently equipped with an "AE6" engine, in which the engine canopy with the control board and steering wheel may be clearly seen. In passing, it may be noted that the Gill shrouded propeller has been adopted for these boats, on account of its ability to withstand the damaging effect of the larger stones found among the beach shingle and because the shrouding prevents the propeller from being entangled with ropes, &c. Figs. 2 and 3 show the port and starboard sides of the engine, and Fig. 4 on the next page gives longitudinal and cross sections. The engines are finished in white enamel, with the screws and bolt heads picked out in black. This finish, we are informed, has been found to be most satisfactory under service conditions, and has definitely encouraged cleanliness both in the engine spaces and in boat stations.

SOME CONSTRUCTIONAL DETAILS.

From the sectional drawing of the six-cylinder engine reproduced in Fig. 4 it will be seen that the crank case casting carries the seven main bearings for the crank shaft as well as the cam shaft bearings. At the after end of the crank case a circular facing is provided for the attachment of the reversing and reducing gear.

The casing is extended down well below the crank shaft bearings, forming a sloping chamber—see Figs. 4 and 5—in which the oil distributor and its connections are housed. The bottom of this chamber is closed by a dished sump casting to the lowest point of which the oil scavenge pump suction is coupled. An alloy steel crank shaft with seven main bearings, each 1¾in. in diameter, is used. The crank pins are 1½in. in diameter and have a length of 1½in. The webs are machined all over and the shaft is balanced. Drilled holes in the shaft and webs form a central passage which communicates with all bearings and is supplied with oil from the distributor connections attached to the underside of the bearing caps. At the after end the shaft is tapered to take the fly-wheel coupling, beside which the main spiral gear drive for the cam shaft and the auxiliary mechanisms is mounted. The engine bearers may be remarked upon. They are light but rigid and are formed by the extension of the box girder construction of the main bearing webs, as seen in Fig. 3. On either side of the crank case there are inspection doors giving access to the tappets and the revolving parts. The cylinder block casting is made of close-grained hard cast iron of thin section and is secured to the crank case by studs. The pistons are of the "BHB" patented type with a slightly domed crown supported from the gudgeon pin bosses by two oblique struts. The manner of support is such that the portion of the piston head carrying the rings is free to expand independently of the skirt. The head of the piston, with the exception of the supporting struts, is entirely separate from the skirt, which in turn is slit in an oblique direction on its unloaded side. When working, the skirt expands due to the pressure on the head, which is transmitted through the struts. This expansion enables very fine clearances to be used, and definitely prevents piston slap. We may say that the engine we saw under test at Elstead ran remarkably quietly at all loads. Three compression rings and one scraper ring are fitted, the compression rings being of the hammered concentric type. The hollow hardened steel gudgeon pin is a floating fit both in the small-end bush and in the piston bosses, and bronze buttons are fitted to it at either end to keep it in position. Splash lubrication of the gudgeon pin is provided for by drilling suitable holes in the small end. The connecting-rods are drop forgings of H section made in heat-treated duralumin with small solid ends, and their length between centres is 6½in. The big ends are of the claw type with two bolts. Both the main bearings and the big-end bearings are die cast into bronze shells.

A feature of the design is the provision of a cylinder head which is small and light enough to be lifted for examination by a single attendant. The head is made of cast iron and carries the necessary ports for the induction and exhaust as well as communicating passages for carburetter air. On one side of the combustion space is arranged a pocket for the accommodation of the two sparking plugs. Large cleaning doors, which give access to the water jacket spaces, are provided at each end of the cylinder head. The cooling water is conveyed from the cylinder jacket boxes into the head through spigot bushes fitted with rubber rings which make the water joints and isolate the main cylinder joints from contact with the circulating water. To one side of the cylinder head there is attached a box which carries the ignition wires from the magnetos. Access to each pair of plugs is obtained by removing the valve mechanism cover.

An aluminium casing covers the whole of the valve mechanism which is mounted on the top of the cylinder head. This mechanism is designed for high melting point grease lubrication and can be run for periods of over fifty hours without any attention. The cover is provided with large-diameter pipes for the air feed to the carburetter. The valves are made of suitably heat-treated K.E. 965 steel. They are of the mushroom type, are interchangeable, and are slightly offset on the fore-and-aft centre lines of the combustion spaces. Each valve is kept on its seating by two concentric helical steel springs and 30 deg. valve seatings are used. The valve cotters are of the split double-cone type, wedging on to the valve stem and into the spring holder, the two parts being held together by means of a light spring. The valve rockers are made of high-grade steel stampings, which are mounted on Hyatt roller bearings on an overhead shaft. The ends of the rockers operating the valves are case-hardened while the ends in contact with the push rods are provided with spherically ground adjustable push buttons. For purposes of lightness case-hardened hollow valve tappets are employed, with tubular steel push rods. The cam shafts are made hollow for lubrication and individual oil supplies are taken to all cam shaft bearings and to the cam faces. The driving gear is of the helical type and the wheel is attached to a carrying flange which is mounted on splines at the rear end of the shaft. Differential holes are provided in the wheels and flanges to permit vernier adjustment of the timing of the engine. Each cylinder is equipped with two independent sparking plugs and current is provided by two high-tension magnetos of the polar inductor four-spark pattern situated at the after end of the engine. The employment of these special magnetos enables half the usual speed of rotation to be used. All the high-tension wires from the magneto to the starting plugs are carried through the wire box. The aluminium casing in which the two magnetos are housed is ventilated to the atmosphere, the air being drawn in past the connecting wires into the wire box and thence across the sparking plugs into the carburetter air intake. By this means cool plugs are maintained.

The water pump, which will be seen in Fig. 5, is of the straight tooth gear pattern and runs at 1000 r.p.m. It is driven through an Oldham coupling from a cross shaft at the after end of the engine. It is of specially large capacity

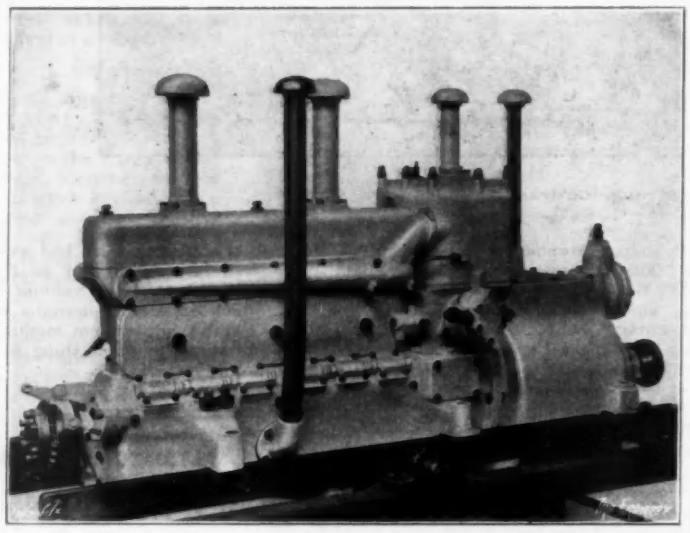


FIG. 2—PORT SIDE OF ENGINE

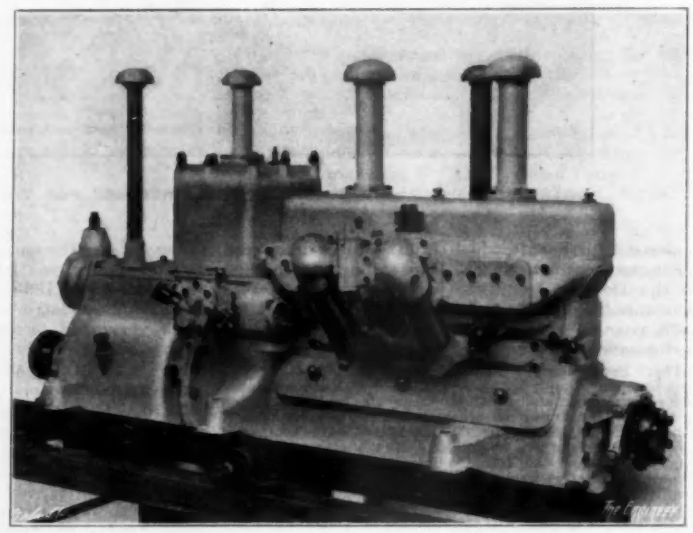


FIG. 3—STARBOARD SIDE OF ENGINE

in order to deal with the closed fresh water cooling circuit. At the other end of the pump shaft there is mounted a duplex oil pump, one section of which scavenges the crank case and the other delivers oil from a tank to the bearings and running parts.

The twin carburetter is a standard Zenith type, made submersible, with a single float chamber, having suitable flanges arranged for its attachment to the air intake tubes. Air enters by way of the air pipes attached to the cylinder head cover, is drawn across the cylinder head and valve mechanism, passes down and through the cylinder

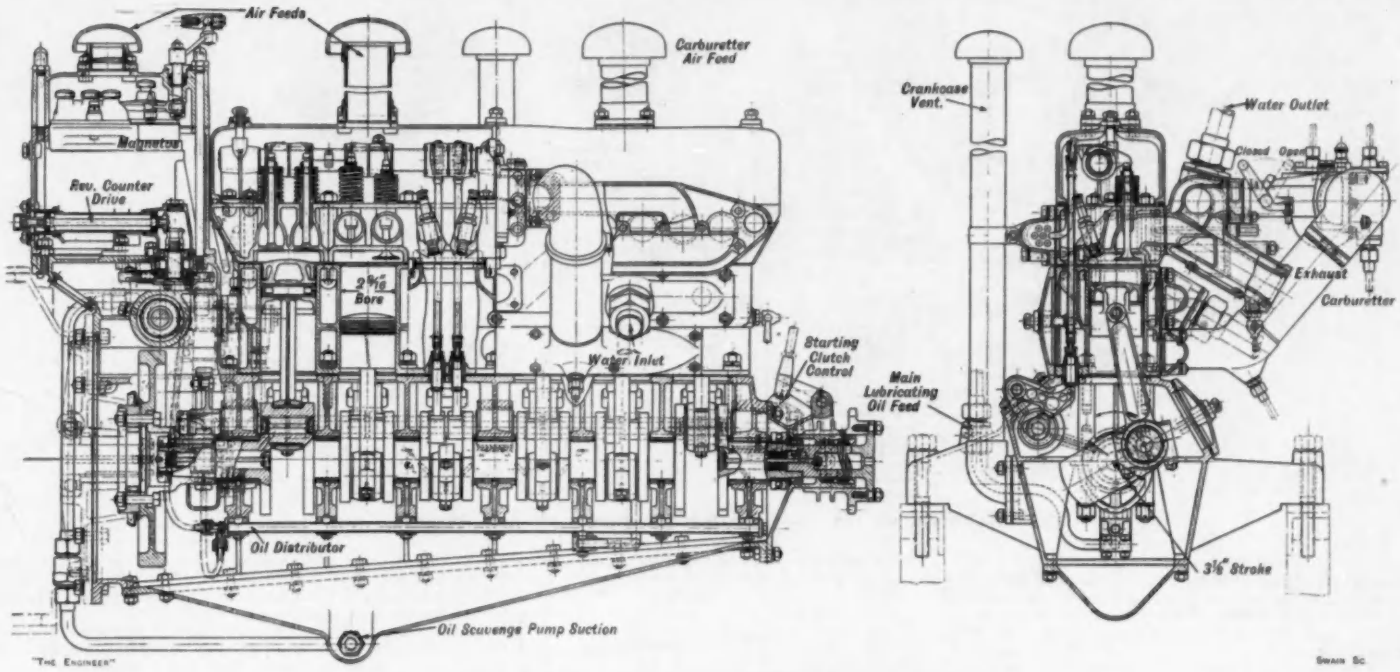


FIG. 4—LONGITUDINAL AND CROSS SECTIONS THROUGH CYLINDERS

block, and enters the air chamber of the carburetter, terminating in a special safety receptacle. The float chamber is vented to the atmosphere by a pipe.

An interesting part of the auxiliary equipment is an automatic valve for preventing the entry of sea water into the exhaust in the event of the boat suddenly capsizing. A drawing of this valve is reproduced in Fig. 6, from which it will be observed that its operation is controlled by a pendulum weight with a roller path on its underside, which, when the boat attains a predetermined angle of roll in either direction, moves to the

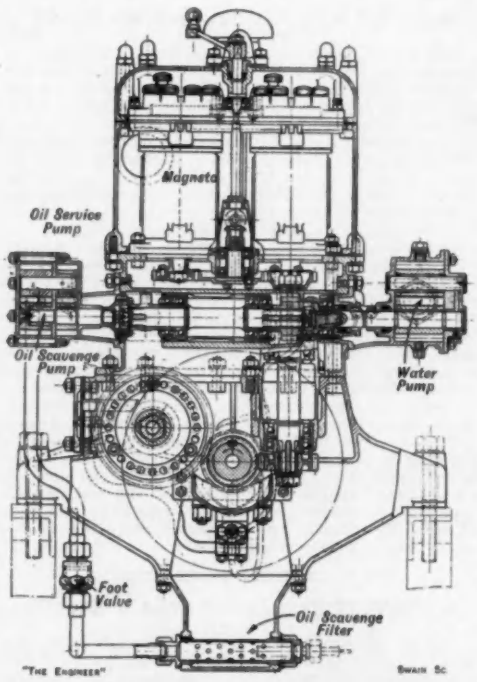


FIG. 5—END SECTION THROUGH PUMPS

side and the roller, which is supported in a stirrup forming the lower part of the control valve, is thereby released as the weight passes through the stirrup and so allows the valve to close under the action of the spring. The valve remains closed until the engine is re-started on an even keel, when the exhaust gas pressure automatically resets the trigger mechanism. This valve is arranged to be free to close slightly in advance of the device provided for the automatic cutting out of the engine ignition in the case of capsizing. Special arrangements are also included in the pipe system to ensure that there is an uninterrupted supply of lubricating oil and cooling water.

Reduction and Reverse Gear.

The reducing and reversing gear fitted to the engine is of the Garrard-R.N.L.I. patented type and is designed to reduce the full load engine speed of 3300 r.p.m. to a propeller shaft speed of 900 r.p.m. ahead or astern. A general arrangement of the gear is shown in Fig. 7, and Fig. 8 is a diagrammatic sketch by means of which the principle of operation is more clearly explained. The gear follows the Garrard principle of employing the adhesion of hardened rollers and rings automatically pressed together, which was fully described and illustrated in THE ENGINEER of March 12th, 1926, but the arrangement adopted in the present gear is a modified form of the earlier gear, which has been successfully employed for speed changing on electric motors of the Crocker-Wheeler type in America. Referring to Fig. 8, and dealing first with the ahead gear shown to the left of the diagram, it will be seen that there are four satellite rollers surrounding a parallel centre sleeve and enclosed within two hardened steel rings, the inner surfaces of which are curved and make contact with conical portions of the satellite rollers. The angle at which this contact takes place encloses 14 deg., as indicated, this angle having been found by experiment to be the most efficient. In order to create an adhesion pressure proportional to the torque being transmitted by the gear at any time, there is provided a free centre ring between the two main rings, as shown in the diagram on the left of Fig. 8. The centre ring is furnished with inclines or ramps on each of its faces, which engage with inclined hardened cam pieces attached to the main rings. The ahead brake drum C is bolted to the left-hand ring only. As soon as any small degree of slip occurs between the held ring and the satellite rollers the opposite ring is carried forward and arrested by the inclined cam pieces, thereby forcing the two main rings apart through the agency of the ramps faces on the loose centre ring. As the two main rings are forced apart pressure is transmitted from them to the inclined surfaces of the rollers, which in turn are forced down on to the centre driving sleeve at the requisite pressure for adhesion to transmit the engine drive at the required speed reduction fixed by the diameters of the sleeve and rollers selected. It will be seen that when the drum C is held by the brake shoes referred to later the rollers of drum C engage with the stationary rings and cause the cage A to rotate in the same direction as the driving shaft; the cage A being attached to the flange of the driven shaft rotates this shaft in the same direction as the driving shaft.

Considering now the astern drive, it will be seen from Fig. 7 that the cage A of the ahead drive is coupled to the left-hand ring of the second set of rollers for the astern drive shown to the right of the diagram, while the cage B —Fig. 8—is fastened to the astern brake drum D. To obtain the same ratio of speed reduction in the astern direction a slightly smaller driving shaft is used with correspondingly larger diameter satellite rollers. When drum D is held and C released the rings of drum D will rotate, carrying with them cage A in the opposite direction to that of the driving shaft, namely, the astern direction. The pressure necessary for adhesion is obtained in the same way as for the ahead drive with two main rings and a loose ring in between them, the required resistance to expand the rings being provided by the torque reaction set up by the propeller. In order to start the expansion of the rings springs are mounted between them in both ahead and astern gears, which impart an initial pressure. When under load this initial pressure is taken up and increased by the action of the inclined cam pieces and the corresponding ramps in the centre rings.

Referring to Fig. 7, it may be noted that the lubricating oil necessary for the gear is drawn from the sump through a foot valve and introduced through a circular groove in the end cover and a hole through the coupling. It then passes to the hole drilled up the centre of the driving shaft, finally reaching the rollers and rings through the small holes drilled radially into the central oil hole. The height of oil in the sump at the bottom of the gear case is kept well below all the revolving parts.

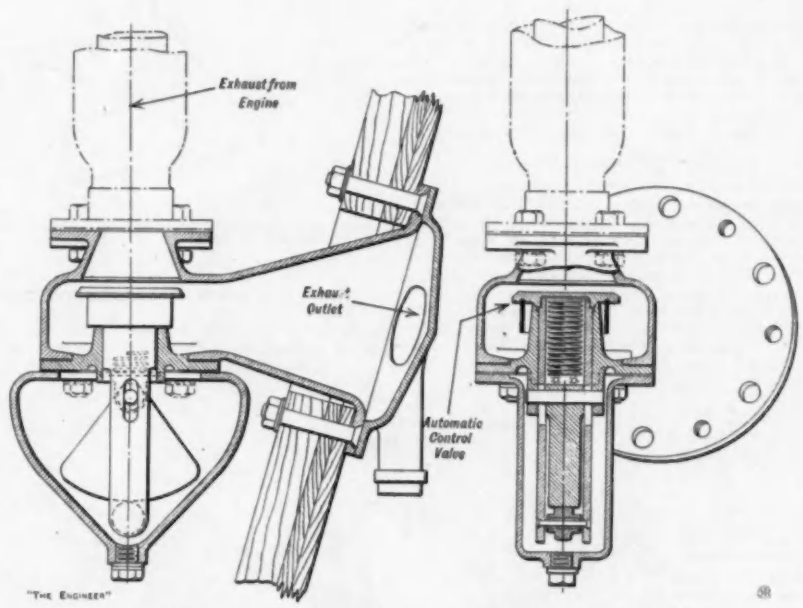


FIG. 6—ARRANGEMENT OF AUTOMATIC EXHAUST CONTROL VALVE

Control Arrangements.

The ahead and astern motions and neutral position are all obtained by rotating the control wheel extension fitted to the vertical shaft at the top of the gear, which in turn rotates the operating shaft through a bevel gear and brake locking mechanism. Cams for pressing the brake bands against the drums are provided, and these particular parts are clearly indicated in the end view of the gear to the

right of Fig. 7. The locking device, indicated in the small drawing above the two views, is a feature of the brake-operating mechanism which indicates the care with which all details of the gear were considered by the Institution's engineers before they finally approved the whole design.

Reference to the sectional view of the locking arrangement shows that it consists of a flange coupled to the bevel gear, which has three projections, a cam piece coupled to the operating shaft, and a number of rollers supported circumferentially by springs in plungers and enclosed by a ring in the gear case. When the control wheel is turned the operating shaft does not rotate until the rollers which are pushed round by the projections on the ring come into contact with the radial portions of the cam piece. By this time the rollers at the opposite ends of the projections have been carried round by the springs and are ready to prevent the return motion by becoming wedged between the internal diameter of the stationary ring fitted in the gear case and the cams. Thus, when the desired amount of rotation of the operating shaft is completed it is impossible for the shaft to turn in the opposite direction until the rollers are freed by a sharp pull on the control wheel.

The mounting of the brake bands on the anchor shaft at the bottom of the gear is also interesting. The provision of intermediate shafts for attaching the brake bands to the triangular blocks pivoted on the anchor shaft permits the brake bands at either side of the drums to adjust themselves so that they are both in proper contact. By mounting the revolving parts of the gear on anti-friction bearings it is further ensured that the high standard of efficiency to be expected from a gear of this type is not impaired. In addition, the gear has, we noticed on test, the undoubted advantages of silent and vibrationless performance. That it also has the necessary degree of dependability for the special class of duty it has to perform has, we learn, now been proved in actual service.

Service and Performance Results.

The present building programme comprises in all twenty-seven six-cylinder engines, of which number nineteen are in service in eighteen boats, one of these boats being a twin-screw unit. Four engines are now being installed in three boats under construction, while a further four are available for future requirements, it being expected that in a later programme for other stations other boats will be engined with this same type of machinery. Late in 1929 two engines were put through experimentally, and the first of them ran a type test of fifty hours in ten-hour non-stop runs at full throttle in the ahead direction, followed by ten hours in an astern direction, the second engine running a similar but slightly shorter test.

Typical performance curves taken with the engine running under test bed conditions at Elstead are reproduced in Fig. 9.

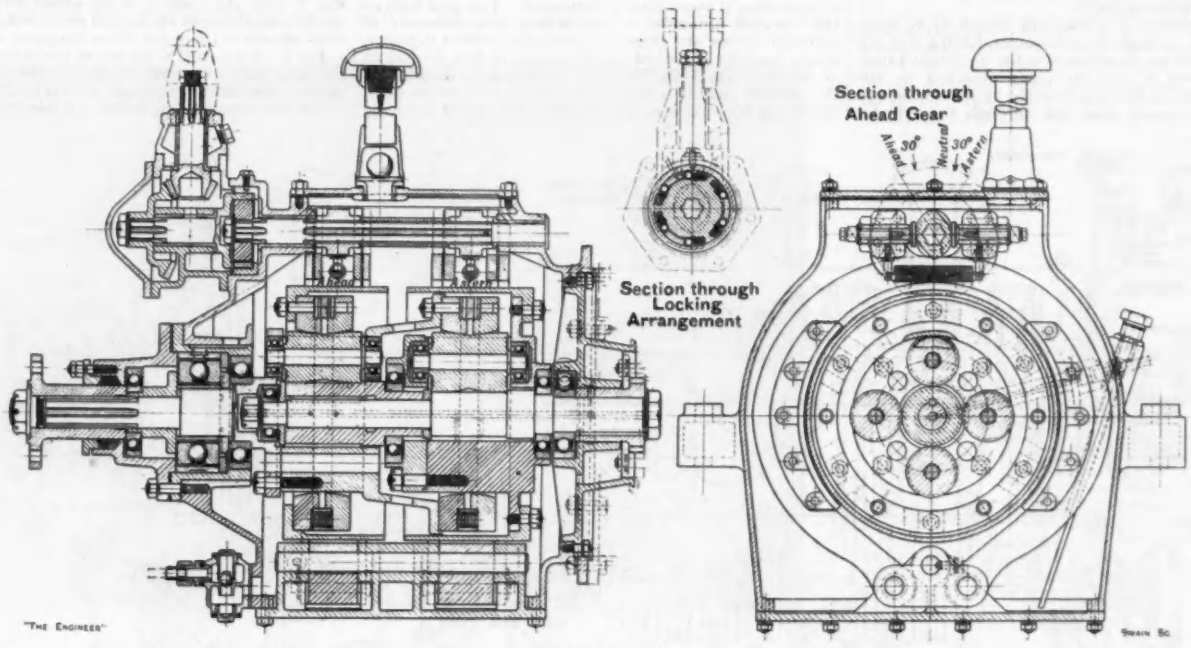


FIG. 7—SECTIONS OF THE GARRARD-R.N.L.I. REDUCTION AND REVERSE GEAR

The first engine to be put on service was installed in a 35ft. 6in. self-righting boat placed at Hythe, Kent, on January 8th, 1930, and the second in a similar boat placed at Berwick-on-Tweed on February 28th, 1930. A considerable amount of testing and demonstration work has been done with these boats. The Hythe boat attended a Lifeboat Conference at Calais on August 15th, 1930, and the Berwick-on-Tweed boat made the passage to her station from Cowes in very bad weather during February of that year. The boats of this type are primarily for inshore and sandbank work and are usually transported and launched from a carriage. Two of them, however, permanently lie afloat, whilst one or two are housed and launched from slipways.

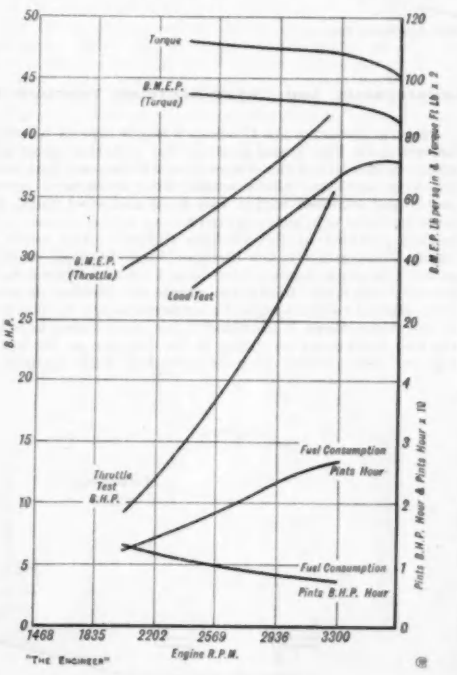


FIG. 9—TYPICAL PERFORMANCE CURVES

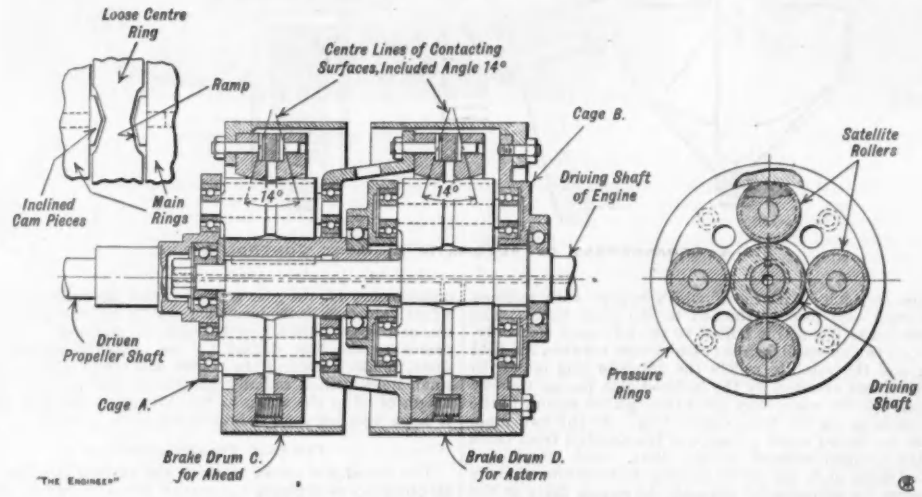


FIG. 8—DIAGRAM OF REDUCTION AND REVERSE GEAR

The engine of the Hythe boat was completely dismantled for survey after approximately 350 hours' operation, when it was found that, apart from minor adjustments, no wear or defects in design were disclosed. We would congratulate the Royal National Lifeboat Institution and the Weyburn Engineering Company, Ltd., on the production of a high-speed light-weight engine of merit which has fulfilled in every respect the objects for which it was designed. The successful results have been attained by the close co-operation of Capt. H. F. J. Rowley, C.B.E., R.N., the late Chief Inspector of Lifeboats; Engineer-Captain A. G. Bremner, R.N. (Ret.); Mr. A. C. Butcher, M.I.A.E.; and Mr. F. C. Ashby, A.M.I.A.E.; and the personal supervision given by Mr. Hamilton Gordon in the construction of the engines at Elstead. The engine is one which should further advance the high prestige of British lifeboat work.

A LARGE SLEEPER CREOSOTING PLANT.

The new sleeper creosoting plant of the L.M.S. Railway Company at Beeston, near Nottingham, which has just been completed under an important modernisation scheme, now has an output of over 1000 railway sleepers per day. The designed output of the works is 365,000 finished sleepers per annum, and the plant consumes 1,000,000 gallons of creosote a year. From February to September, during which period intensive track relaying is in progress in various parts of the L.M.S. system, over 10,000 sleepers will be despatched from the works each week, in addition to large quantities of other creosoted timber.

The new plant includes two large creosoting cylinders, each holding 450 sleepers, with a length of 79ft. and an internal diameter of 6½ft. The cylinders are fitted with high-capacity steam ejectors for obtaining the necessary vacuum, while a pressure of 200 lb. per square inch is obtained from electrically driven pumps. Recording apparatus is provided to indicate the temperature, pressure and volume of creosote during the process of creosoting. Among other new machines which have been installed are an adzing and boring machine, which saws the sleepers to the standard length of 8½ft., adzes the surface and bores holes for screws, at a rate of six sleepers a minute; a ferruling machine, which automatically presses the ferrules into the chairs at the rate of fifteen chairs a minute; and two screwing machines, the first of their type to be introduced on the L.M.S. railway system, each of which automatically screws the chairs to the sleepers at the rate of five sleepers per minute.

A CONVERTED MARINE STEAM ENGINE.

During the course of this week Alex. Stephen and Sons, Ltd., Govan, Glasgow, have been carrying out test-bed trials of the twenty-five-years-old triple-expansion engine of the s.s. "Annan." This engine has been modified by fitting three new cylinders having diameters 16½in., 26½in. and 46in., in place of the original 22½in., 35in. and 59in. cylinders. The H.P. and I.P. inlet and exhaust valves and L.P. inlet valves are of the Andrews and Cameron independently balanced type, operated by slotted cams off the existing Stephenson link motion. A pair of twin-furnace Scotch boilers provides steam at 200 lb. pressure, as compared with the 165 lb. formerly used, and a superheat of 100 deg. Fah. has now been adopted. The I.P. and L.P. receivers are separate from the cylinders, and are formed from steel sheets, electrically welded. The L.P. is a uniflow cylinder, and spring-loaded relief valves relieve the compression when the vacuum falls. Except that a cracked condenser has been replaced by a welded steel one, no other important changes have been made. We hope to give a fuller description of the new arrangement, which develops about 1000 I.H.P., in a subsequent issue.

Railway and Road Matters.

The section of the Federated Malay States Railways passing through Singapore to the terminus is being rebuilt on a new alignment for a distance of 9¼ miles. The new route will entirely avoid level crossings. A new terminal station, with platforms 950ft. long, is also being built.

The Marble Arch Station on the Underground is used by 5,000,000 passengers a year, as compared with 3,500,000 five years ago. The improvements thus called for include booking-offices below the street level, with, additionally to the main entrance on the north side of Oxford-street, one at the top of Park-lane and one near the entrance to Hyde Park. The reconstructed station will be opened on August 15th.

The question of closing down the rail mills at Crewe and of purchasing the rails required by the London, Midland and Scottish Company by contract—mentioned herein on June 10th last—has evidently been postponed, as it is officially announced that orders have been placed with Crewe works for over 200 miles of rail, which will require 5000 tons of steel. This order will keep the steel works busy up to Christmas, and find full employment for 300 men.

In reply to a letter from the Mayor of Gateshead as to the closing of the L. and N.E.R. locomotive works, Mr. Whitelaw has stated that the company had no alternative but to close the locomotive shops in Gateshead. Considerations of economy rendered imperative a concentration of repair work at Darlington, but the change would be carried through with the utmost consideration for all affected. About a thousand workers are concerned in the change.

The Southern Railway Company's receipts for the half-year ended June 30th were, compared with the corresponding period of 1931, down by £550,000 in passenger traffic and by £250,000 in goods. An economy of £500,000 was made in the expenditure. The Great Western had a drop of £436,000 in passenger traffic and of £600,000 in goods. Expenditure was reduced by £900,000. The gross receipts of the London and North-Eastern fell by £2,420,000 and an economy of £1,496,000 was effected.

Twice within the last six weeks the newspapers have reported the death of a signalman on duty. As on the earlier of these occasions it was emphasised that the man's death was discovered by no reply being received to the block telegraph signals sent from the adjoining signal-box, we would say that that is the safeguard against an accident resulting through the occurrence of such an unfortunate incident. No train is allowed to leave a signal-box in the rear until the signalman in advance has been asked on the block instruments if the train may be sent, and he has accepted the train by turning the indication on his own instrument, and on that in the signal-box in the rear, to Line clear. If, as in these two cases, anything had happened to the signalman at the box in advance, he could not accept the train, and that would lead to an inquiry as to the reason. If the signalman were, for instance, taken ill after he had accepted the train, the non-receipt of the intimation that the train had arrived would soon lead to the fact being discovered.

The recently issued annual report on railway accidents records that 159 railway servants were killed last year in what are known as "movement" accidents, *i.e.*, in the movement of vehicles other than in train accidents. Adding that figure to those for the previous four years, we find a total for the five-year period 1927–31 of 969. On reference, however, to the reports for thirty years ago, we learn that the total for the five-year period 1901–05 was no less than 1794, or nearly twice as many as at the present time. The two totals, it should be noted, were with about 700,000 men, as against 617,000 to-day. It is appropriate to draw attention to this great improvement, as on August 8th it was thirty years since the first Rules were issued under the Railway Employment (Prevention of Accidents) Act, 1900, which were the result of recommendations made by a Royal Commission appointed in 1899 to consider that important question. This subject was dealt with at length in an article that appeared in The Engineer of May 29th, 1931, on the twenty-fifth anniversary of the formation of the Railway Employment Safety Appliances Committee.

The paragraph in our Seven-Day Journal on July 29th as to the much-needed modernisation of Buchanan-street Station, Glasgow, may be supplemented by a brief record of the history of railway communication in the city of Glasgow. That record was noted at some length in the article of our series "One Hundred Years of British Railways," which appeared in The Engineer of November 28th, 1924. The first railway in Scotland was the Kilmarnock and Troon, sanctioned by 48 Geo. III., c. 46, of 1808, and opened in 1811. The Monkland and Kirkintilloch, authorised in 1824 and completed in 1826, was followed by two other lines in the same vicinity, the Ballochney and the Slamannan, which respectively were sanctioned in 1826 and 1835, and opened in 1828 and 1840. In 1826 there was also authorised the Garnkirk and Glasgow Railway, which ran from Gartsherrie on the Monkland and Kirkintilloch Railway, by Garnkirk, to a terminus in Glebe-street, Glasgow, which is now part of the St. Rollox mineral yard. That line was opened on September 27th, 1831. The first section of the Caledonian main line from Carlisle was brought into use as far as Beattock on September 10th, 1847, to be followed on February 15th, 1848, by the line throughout to Edinburgh and from Carstairs on the same date to Garriongill. The last-named place was on another small railway—the Wishaw and Coltness—which, authorised in 1829 and completed throughout in January 8th, 1842, joined the Monkland and Kirkintilloch, and so, by it and the Garnkirk and Glasgow, passengers for Glasgow reached that city by means of the station in Glebe-street. In November, 1849, a new line, half a mile in length, ran from Milton Junction, north of Glebe-street, into Buchanan-street, which station remained the Caledonian Company's principal terminus in the city of Glasgow until the river Clyde was bridged from Bridge-street to the Central Station, which was opened on August 1st, 1879.

Notes and Memoranda.

A little cutting from *Indian Engineering*: "They [the sages who wrote the treatise on the irrigation of early India] did not understand the manual arts and probably did not want to, while the artists who did understand could not write and were also inarticulate in expressing themselves by word of mouth."

The deposits of rock phosphate in Palestine are very extensive, covering an area of about 100 square kilometres, amounting to 1000 million tons. The better qualities contain from 40 to 50 per cent. tricalcic phosphate. Experiments have been carried out for their utilisation locally by direct application as ground powder with successful results; other methods are also being tried.

A correspondent describes in *Power* a simple, yet ingenious improvement in the floats used for operating ball cocks. The floats are usually attached to their levers in a more or less horizontal direction, which results in considerable bending stresses in the fabric of the float, and possible failure through cracking. So Mr. S. R. Stevens bends the lever so that it approaches the float from beneath, and consequently gets an even distribution of the stress.

In steel castings the effect of the addition of molybdenum has been to increase the response to heat treatment and to promote depth hardening. In cast irons, molybdenum seems to markedly strengthen the iron without increasing its machining difficulties. There also are indications that the iron possesses improved wear-resisting qualities under conditions of elevated temperatures and hence such molybdenised cast iron should be particularly suitable for brake drums.

Utilitarian applications of chromium plating are becoming as common as decorative uses, says the *Iron Age*. The plating of steel mill rolls with chromium is one of the latest developments and one of great promise. Plated rolls with a high mirror finish are now being used in strip mills. Chromium is also being applied to leveller rolls, cold-sheet rolls, tin-plate rolls and tube-forming rolls. An interesting use of chromium plating is in reclaiming roll necks that have been accidentally machined undersize.

Investigations carried out in the Mining Research Laboratory of the University of Birmingham on the pre-treatment of coal for hydrogenation have shown that by preheating certain coals in the absence of added hydrogen or of oxidising gases to a temperature of between 300 deg. and 470 deg. Cent. and subsequently hydrogenating in the usual manner, a larger conversion of the coal into oil is possible than by direct hydrogenation of the untreated coal. Experiments have shown that steam has an appreciable oxidising action on coal, in the case of certain coals even at a temperature as low as 250 deg. Cent., and further, that the presence of water in coal exerts an inimical influence upon the hydrogenation process.

The new four liners of the Grace Steamship Company, of America, which are to work between New York, San Francisco, and Central America, will have every stateroom on the outside, each of which will be equipped with its private bath. The dining salons are two decks in height and are designed with domed roofs capable of being slid back so as to become practically open-air restaurants. Each ship will have on the after deck a 40ft. swimming pool, the largest outdoor pool ever to be constructed on any ship. Open-air verandah cafés will overlook them and promenade decks of unusual width will emphasise the purpose of the architects in designing vessels to meet weather conditions of prevailing mildness characteristic of the route.

It is sometimes required to heat-treat ball rings the analysis of which is not known, says A. C. R. in *Machinery*. For example, they may have been softened for boring out to suit a particular shank. While it is difficult to give a definite heat-treatment instruction when analysis is not known, one or other of the following methods should prove satisfactory. Heat to 780–800 deg. Cent. and cool in oil. If this does not make the ball races hard enough, heat to 780–800 deg. Cent. and quench in water for about five seconds, then cool off in oil. If this again proves unsatisfactory from the point of view of hardness, heat to 780–800 deg. Cent. and quench in water. All these treatments should be followed by tempering at 200 deg. Cent. in an oil bath.

A report by the Engineer Surveyor-in-Chief to the Board of Trade, deals with an explosion from a Stirling water-tube boiler due to the rupture of a tube which had become seriously wasted externally. A number of tubes in the vicinity of the one that ruptured and corresponding tubes in the other Stirling boiler at the works, were found to be similarly affected, and there is no doubt that they had been gradually reduced in thickness locally by the erosive action of the steam jets from the soot blowers. The boiler which failed had been inspected about two months before the explosion occurred, but apparently the wasted tubes presented a smooth appearance giving rise to no suspicion as to their actual condition. The application of hydraulic tests, after careful inspection, at regular and frequent intervals is a precautionary measure which might well be adopted in regard to boilers of this type."

Mr. K. St. G. Cartwright, of the Forest Products Research Laboratory at Princes Risborough, is of the opinion that many cases of dry-rot in timber could be dealt with by removal of all obviously decayed timber and the instalment of an efficient central heating system, coupled with adequate ventilation. This would in many cases be far less expensive than the usual means adopted. Of course, if the heating was uneven, the risk might be increased, owing to the possibility of the condensation of water taking place, but where even heating was secured, he feels certain that the fungus threads would be dried up before they were able to get a hold on the wood. If attack was found to be due to *Coniophora* or *Paxillus*, the case was much more easy, as neither of these fungi could develop on dry timber, both requiring abundant moisture, so that remedial measures need only be the removal of badly decayed wood, the drying out of the moisture, and preventing further access of damp.

Miscellanea.

Some 30,000 tons of scrap iron are to be sent to Japan from South Africa, through Durban.

The Textile Machinery Exhibition is to be held in the Granby Halls, Leicester, from October 7th to 15th.

A pipe line is to be constructed from Bolivia to the Chilean coast with the accord of the Chilean Government.

The Model Engineer Exhibition is to be held at the Royal Horticultural Hall, Westminster, from September 1st to 10th.

It is stated that chrome ore containing about 55 per cent. of chromic acid, can be shipped at Durban, Natal, at the price of 8s. 6d. per short ton.

Progress in the construction of the new steel works at Pretoria, South Africa, is going on so well that it is expected to produce iron early in 1934.

The latest natural gas well brought into use in Canada, one on the Kinsella field, near Edmonton, Alberta, is said to have a flow of 7,600,000 cubic feet a day.

The new Canadian Pacific Railway tunnel under Vancouver, connecting the False Creek Yards with the tracks on Burrard Inlet water front, has been opened. It is 4600ft. long and is an important matter in the elimination of level crossings in the city.

An order has been placed in Britain by the Belgian Government for a number of 200 H.P. Armstrong-Siddeley aero-engines, which are to be installed in fighting aeroplanes for the Belgian Air Force. With the exception of a few out-of-date craft, all the machines of the Belgian Air Force will be now equipped with British aero-engines.

Work has progressed so favourably on the construction of the canal from the Gulf of Finland, through lakes Ladoga and Onega, to the White Sea, that it is expected it will be ready for service next spring. The length of the canal proper is about 140 miles, and it is not being made, so far, for more than comparatively shallow-draught vessels.

The number of ships which passed through the Suez Canal in July was 396, compared with 438 in July, 1931. Receipts were 61,920,000f., against 75,820,000f. For the seven months January to July, 1932, the number of transits were 2897 and total receipts were 458,330,000f. Corresponding figures for 1931 were 3283 transits and 567,960,000f., according to the *Suez Canal Bulletin*.

Large deposits of zinc ore have been discovered in the Kazakstan area of Russia. Preliminary estimates indicate that the deposits contain 15½ million tons of zinc ore, the pure metal content being from 3 to 4 per cent. This would bring the deposits to the second place in importance in the Soviet Union. The ore lies on the surface, so rendering it easy to work.

Plans are being drawn up, says the *British Russian Gazette*, for the construction of a great resin, turpentine, and cellulose combine in the Leningrad province. The annual output is planned at 2750 tons of resin, 540 tons of turpentine, 270 tons of resin oil, 5800 tons of cellulose, and 1000 tons of resin soap. It is planned to cost 8,200,000 roubles, and should be brought into operation at the end of 1933.

All records for a single cargo handled through the new Welland Canal, in Canada, were broken recently when the steamer "Gleneagles," of the Canada Steamship Lines, brought to the dock of the Steel Company of Canada a cargo of 12,912 tons of coal for use in that plant. Opening of the new canal permits shipments of coal, stone, and ore to be brought direct to the steel mills without breaking bulk, and is counted on to result in major economies for the Canadian blast-furnaces and mills.

According to *Kohle und Erze*, the advantages of powered gypsum used for stone dusting in collieries are (1) its white colour, which makes it more conspicuous; (2) its moisture content, which enables it to absorb 50 per cent. more heat at 1000 deg. and 90 per cent. more heat at 500 deg. than the usual stone dust used; and (3) its effect on carbon monoxide, which in the case of a hot after-damp it oxides nearly completely to dioxide. Other advantages of its use are that it does not produce silicosis or similar disorders of the lungs, and that it acts as a prophylactic against tuberculosis.

As a preliminary to the development of the Periyar hydro-electric scheme, in Madras, for which detailed plans and estimates have now been submitted to the Government of Madras, it is proposed, says *Indian Engineering*, to install generating plants driven by oil engines at Virudhunagar, Dindigul, and Palni to supply electric power to those towns and their environs. This scheme, which, it is proposed, shall be undertaken under the auspices of the Government of Madras, promises to be an attractive commercial enterprise, as there is a considerable demand for power in the area concerned. The oil engine sets, which are second-hand, will be scrapped after the development of the Periyar scheme.

According to the *Financial News* (Vancouver), an extensive placer mining operation is to be got under way at once on the Bridge River. Hydraulic mining is to start on the benches and it is estimated there are 6,500,000 cubic yards of gold-bearing material on the north benches and 2,500,000 cubic yards on the south benches. Extensive drilling and other testing has been done, indicating 1·17 dollars in gold to the yard on the south benches, 1·65 dollars in the river bed, and 1·23 dollars on the north benches. The company has installed 2300ft. of pipe line, and built 5300ft. of open canal to convey water from Seven Mile Creek to the main monitor station. The pipe line, which tapers from 36in. to 12in., provides an operating head of nearly 500ft., and sufficient volume of water to operate three or four big monitors during seven or eight months each year. It is expected that initially 2000 cubic yards of gravel will be handled daily. In addition to the 8in. monitor, a 6in. and two 4in. monitors are on the ground, and with this equipment and the duplication of the first line of sluice boxes it is expected that capacity may be brought up to 5000 to 8000 yards a day.

L.N.E.R. LOCOMOTIVE COALING PLANT AT HULL

BABCOCK AND WILCOX, LTD., RENFREW, ENGINEERS

(*For description see page* 165).

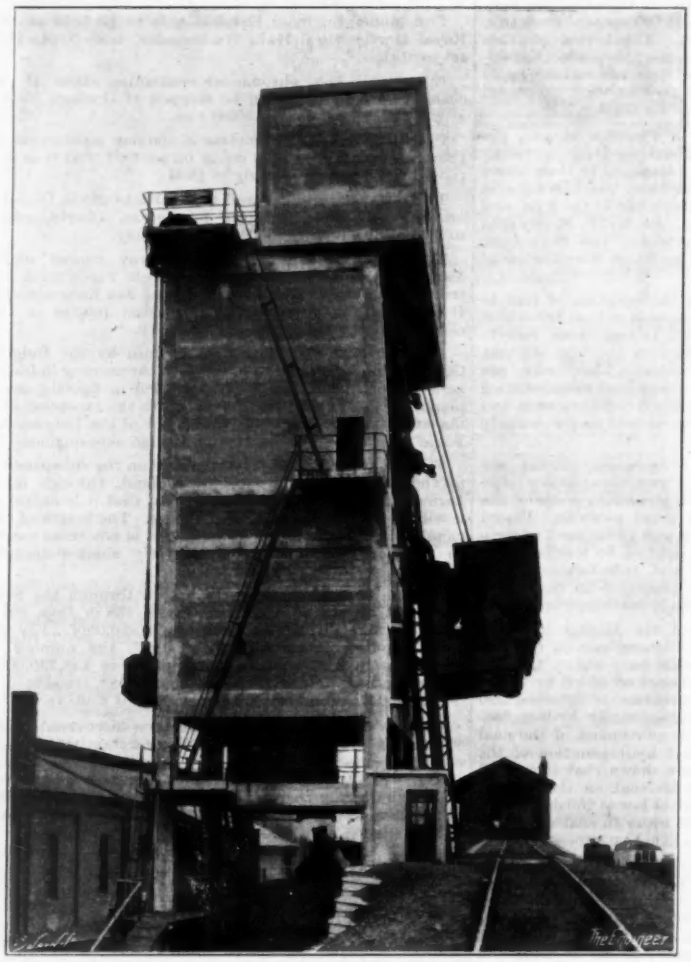


FIG. 1—END VIEW SHOWING HOISTING OPERATION

FIG. 2—SIDE VIEW SHOWING TIPPING OPERATION

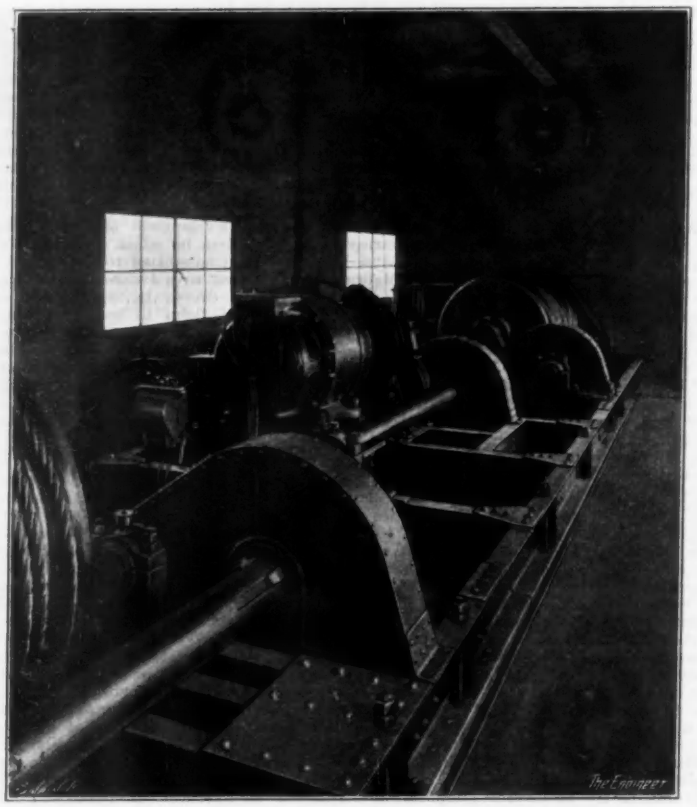


FIG. 3—ARRANGEMENT OF HOISTS AND DRIVING GEAR

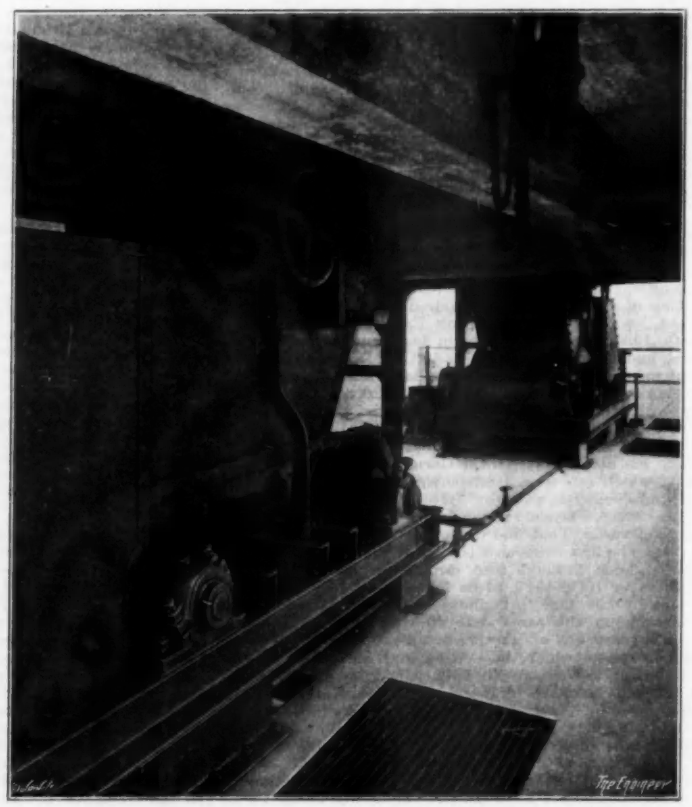


FIG. 4—VIEW OF COAL FEEDER PLATFORM

The Engineer

AUGUST 12, 1932.

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THE LIMITATION OF ARMAMENTS.

WHEN the Disarmament Conference began its first session at Geneva last February there cannot have been many people, other than incorrigible idealists, who anticipated far-reaching results from its labours. In the opinion of most realists, the growth of armaments is a symptom of world unrest rather than the root cause of that phenomenon. It is, for instance, a demonstrable fact that the mainspring of most of the international unheavals of the past twelve months has been economic distress. War debts, reparations, tariff barriers, and the like seem to us to exercise a much greater influence than navies, armies, and air fleets on the political relationships of the Powers. For that reason we attached far more importance to the results achieved at the Lausanne Conference on economic problems than to the somewhat attenuated sheaves which were brought home from Geneva. The Disarmament Conference had been in session for nearly six months, and before it met a Preparatory Commission had been at work for about six years, attempting to lay the groundwork for the Conference proper. What is there to show for these prolonged labours? Merely a resolution prohibiting the aerial bombardment of civilians and the employment of chemicals and bacteria in warfare. On the surface that is something gained, but we cannot forget that similar resolutions, solemnly passed at Hague Conferences a generation ago, were thrown overboard on one pretext or another as soon as the guns began to speak in 1914. So far as the first session is concerned, the Disarmament Conference has not succeeded in reducing the world's armaments by a single warship or a single battalion. As was only to be expected, the meagre results of the Conference have led to a demand in certain quarters that this country shall give "a strong lead" to its neighbours by cutting down the national defences without regard to national security. Fortunately, there is not likely to be any response to this foolish demand. For ten years now Great Britain has been drastically retrenching her armed forces in the hope of stimulating other Powers to follow her example. But our sacrifices have been vain. We need look no further than the Continent for proof of their futility. During the period mentioned, when British naval construction has remained at a lower ebb than ever before, France and Italy alone have built a total of 275 fighting craft, from heavy cruisers to submarines. We do not blame those Powers for providing what they deem necessary to their security; we merely point to this volume of new tonnage from their shipyards as evidence of the absolute failure of the British policy of promoting disarmament by "gestures" in the form of scrapping or mutilating programmes to which Parliament, after careful deliberation, had given its sanction on the grounds of dire necessity. This policy is now finally discredited, and however much Mr. Arthur Henderson may deplore the comparatively barren results of the Conference over which he has presided, we do not think he will persuade the British Government to take the suicidal step of persisting in unilateral disarmament.

As the Conference is not to reassemble before the end of next January, the protagonists have ample time in which to consider two very important proposals relating to the naval problem, which is of special interest to this country. The first of these proposals was presented by the American Government over a month ago. On the naval side it boldly advocated a reduction by one-third of existing battleship tonnage, a cut of one-fourth in all other surface craft, and the establishment of a maximum of 35,000 tons for the submarine fleet of any one nation. The reception accorded to this plan was not generally favourable. In British circles it is criticised as unscientific, since it ignores the special requirements of individual States and postulates the same degree of dependence upon sea defence for one and all. Its adoption would involve the reduction of the British Empire's cruiser force to thirty-six vessels at most, a strength utterly inadequate for the least emergency which the future may hold in store. By Japan the American scheme has been decisively rejected in a detailed and closely reasoned memorandum prepared by the Tokyo Navy Department. As this document points out, the plan would save the United States the expense of building up her fleet, yet would still leave her with a Navy equal to the most powerful afloat, and with a margin of superiority over the Japanese Navy larger than that conceded by the Washington and London Treaties. But although the plan may be unacceptable in its original form, we believe it to have been inspired by a sincere wish to promote disarmament. In no other country is the battleship so highly prized as in the United States, where it is regarded, rightly or wrongly, as a potential floating base for operations in waters in which friendly shore bases do not exist. Consequently, in offering to abolish one-third of its battleship tonnage the United States has given unimpeachable proof of good faith. The British proposals, as announced in the House of Commons, have the special merit of providing for a drastic reduction in the tonnage and cost of naval armaments without involving any violent dislocation of existing standards of strength. They are based on the premise that "the present Treaty limits of size and gun calibre are far too high, and . . . that very large reductions, amounting to about one-third, both in the case of capital ships and cruisers, can be made in future construction." Mr. Baldwin, who introduced the proposals, went on to explain that the American scheme would leave the Treaty Powers at liberty to build monster battleships of 35,000 tons, with guns up to 16in. calibre. "Every figure involved in these huge dimensions—initial cost, upkeep, *personnel*, ammunition, stores, docks—would be maintained at the highest level." On the other hand, the British plan would not only achieve an equally large reduction in total tonnage, but by reducing the size of the ship and the calibre of its guns, would effect a very substantial saving under all the above-mentioned heads, both initially and consequentially. Under this plan, future battleships would be restricted to a displacement of 25,000 tons, and their guns to a calibre of 12in. As for cruisers, the British Government urges a maximum standard of 7000 tons displacement and 6·1in. guns, in place of the existing one of 10,000 tons and 8in. guns. If this cut in cruiser tonnage and armament were universally accepted, Great Britain would then propose a further reduction in the capital ship standard, namely, to 22,000 tons with 11in. guns. This plan, it is believed, would practically halve the intial cost of any future capital unit, besides greatly reducing the maintenance charges. Ultimately it would effect a reduction, in capital ship tonnage alone, of 195,000 tons, as compared with the figure of 175,000 tons envisaged by the American proposal.

Space does not permit us further to analyse the very detailed British plan, which also provides for a cut in aircraft carrier displacement, the complete abolition of submarines, and a reduction in destroyer tonnage by about one-third, this latter depending on the disappearance of the submarine. Alternatively, if the submarine cannot be completely done away with, Great Britain proposes a maximum surface displacement of 250 tons, together with restrictions both in total tonnage and number of units. As a basis for discussion this plan seems to offer many advantages over the American proposal. If its operation were more gradual, it would, nevertheless, effect in the end, not merely a larger saving in the cost of naval armaments, but a very definite restriction of the aggressive power of individual ships; moreover, as we have said, it would avoid the disorganisation of national defensive forces which would be inevitable under the American scheme. The British proposal would therefore appear to deserve the support of idealists and practical people alike. It has the approval of an overwhelming section of British naval opinion, which is now definitely in favour of a reversion to smaller men-of-war in every category. Save by a small and diminishing school of naval thought, the Fisher doctrine of inflation in tons and guns has been discarded. First accepted twenty-five years ago, and subsequently pursued with more zeal than reason, it ended by raising the cost of naval armaments to a prohibitive figure, and thus threatened to render adequate naval defence impossible on economic grounds. The latest British proposals offer a means of breaking the deadlock and enabling the nations to provide for the defence of their maritime interests without courting insolvency.

Power Factor and Electricity Charges.

EVER since the transmission of industrial power by means of alternating current became general the question of power factor has been a worry to producers and consumers alike. The former have perhaps worried most because they were more directly affected by the evils of a bad power factor, but they were not slow in disturbing the peace of mind of the consumer with their grievances. One of the greatest difficulties was to make him understand what all the trouble was about. He wanted electrical power and was willing to pay for what power he consumed, as registered by the meters. If the power-house chose to send him in addition some mysterious kind of current which could not do any work, and was not even recorded by the wattmeters, it was no business of his, and all attempts at explanation tended to puzzle and exasperate him the more. A generation of educative pressure has done something to improve matters, but even though customers may be more reasonable the vastly greater importance of the industrial load has rendered the power factor problem proportionally more acute. It is by no means impossible for a power station serving an industrial area to have to run all day with a power factor of 65 per cent. or less. The consequence is that far more capital expenditure has to be incurred for machinery and mains than would be necessary to carry the same load under better conditions. The generators cannot be operated at much more than three-quarters of their rated power, the turbines are under-loaded, and extra plant may have to be kept running to take care of the wattless current. The effect on the costs of the station is obvious. The capital charges are increased by reason of the extra equipment required and the operating expenses are greater because the station has to be run inefficiently. Nor is the inefficiency confined to the generating plant alone. It permeates the whole of the system. Transmission lines, transformers, distribution feeders, and motors all pay their tribute to wattless current by increased losses, and these losses are inevitably reflected in the coal consumption of the station per unit of useful power delivered. It is this aspect of the power factor question which forms the subject of a very interesting article by Mr. D. B. Hoseason in the latest issue of the *Fuel Economy Review*. The author gives figures which show that in the case of an ordinary small town served by a 50,000-kW plant the consumption of fuel by the latter would be greater by more than 16·5 per cent. if the power factor of the load were 65 instead of 80 per cent. The figures for an isolated installation of 2000 kW capacity serving a typical textile mill are almost equally striking. In this instance there are no increased transmission losses to be taken into account, and the losses in distribution and transformation are both proportionally less than in a town, but, on the other hand, the average size of the motors is smaller, and there is no sub-station

machinery to have a corrective influence. All things considered, it is estimated that in such a mill a power factor of 65 per cent. will burden the plant with a fuel consumption nearly 11·4 per cent. greater than if the power factor were 80 per cent., and 17·25 per cent. greater than if it were 90 per cent.

If these estimates are even approximately accurate—and Mr. Hoseason's experience in such matters justifies confidence in them—they show how large a field is open for economy. Somebody has to pay for the extra fuel consumed in consequence of a poor power factor, and those who do pay can only be the consumers of electricity, whether they generate it for themselves or purchase it from a central station. It is, moreover, the one item in their total power costs of which they, as a class, have no right to complain. The burden may, and almost certainly will, fall unfairly upon the various consumers on any system, for they are not all equally responsible; but in the aggregate they have it in their own hands to reduce the waste to insignificance. The root of the trouble lies in the ordinary induction motor. This, in most respects, is an excellent piece of apparatus, simple, hardy, reliable, and cheap; but for its efficient performance it should be designed for high speed and be run fully loaded. Even though the user installs the highest speed motors which it is practicable for him to employ, he still has the difficulty of preventing them from working underloaded. They must obviously be put down of sufficient capacity to deal with the heaviest load they will have to carry, and frequently the anticipations of extensions to the plant causes an even greater reserve of power to seem advisable. The owner, however, has several possibilities of correcting the power factor of his plant, and these are considered in turn by Mr. Hoseason. For drives of 100 H.P. and over he thinks the use of salient-pole synchronous motors the best solution, provided the nature of the work permits of their employment. One trouble is in starting them, as starting cannot be effected under any load above 15 per cent. of the normal, and another is their liability to be pulled out of phase and consequently to stop if subjected to a sudden overload. These defects of the purely synchronous motor have resulted in attempts to combine the power factor correcting feature of these machines with the large starting torque of the pure induction motor. Consequently a hybrid machine has been evolved which will start under load like an induction motor, pull itself into synchronism, and then behave like a synchronous machine. Furthermore, should it be pulled out of phase by the load it will continue to run as an induction motor, regaining synchronism by itself as soon as the load permits. These advantages unfortunately cannot be obtained without a certain loss of efficiency, but the synchronous induction motor, as it is called, may well take the place of a purely synchronous machine when the bad starting characteristics of the latter prohibit its use. Another alternative to the synchronous motor is the synchronous condenser, which is merely an over-excited synchronous motor doing no mechanical work. This machine will also give a certain amount of power factor correction, but Mr. Hoseason condemns it almost unreservedly for this purpose on account of its inefficiency. If we regard the synchronous induction motor as an attempt to improve the purely synchronous motor, we find a kind of counterpart in the efforts to improve the purely induction motor by exciting its rotor with alternating current. This is the principle of the "phase advancers" of Miles Walker, Kapp, and others, and of the various high power factor motors now on the market. Between the relative advantages of synchronous induction motors, plain induction motors with phase advancers and high power factor motors, Mr. Hoseason finds it difficult to choose, though he gives some preference to the former when a leading power factor is required and the drive exceeds 100 H.P. For drives of less power, and these, of course, constitute the vast majority, he thinks a static condenser in conjunction with ordinary induction motors is almost invariably preferable to any of the special machines mentioned.

The factory owner has, as we have shown, a number of different ways of correcting his power factor. The difficulty is to get him to employ any of them, for they all involve more or less expenditure on apparatus for the purpose. If he generates his own power the losses due to a bad power factor are on his own shoulders, and he can do what he likes about them. But when he is a customer of a power company the supply undertaking can by no means remain indifferent to the amount of wattless current he is drawing from its system. Its most effective appeal to him is through his pocket by taking account of power factor in some way in its method of charging. The extra metering equipment required to achieve this result is by no means the main difficulty. The whole thorny question of electricity tariffs in general is at once opened up. The company has to consider other things beside power factor in arranging its charges. It wants to encourage the long-hour user, the off-peak user, and the user whose annual load factor is high. It dare not try to charge any consumer much more than he could generate his own power for, or it will never get or retain the valuable industrial load. Its methods of charging must also be fairly equitable between one class of consumer and another, and in addition to all these considerations it must so arrange matters that its aggregate receipts cover the costs of production with a reasonable margin of profit. Important, therefore, as the question of power factor undoubtedly is, it must be seen in its true perspective, as merely one item of one of the most complicated commercial problems. A sub-committee of the Federation of British Industries, under the chairmanship of Mr. J. S. Highfield, has been set up to consider the whole question of electricity tariffs. We read in the official organ of the Federation that "There can be no doubt that the inquiry will be worth undertaking even if it leads to a more or less negative result in that the individual conditions of supply are so individual that nothing of a general character can be applied in establishing the basis of charge." If this is the spirit in which the problem is to be approached, we can only say that it is a deplorable one, and that a result such as that foreshadowed will not only be a grave reflection on the capacity of the committee, but will engender a fatal distrust in the minds of power consumers.

Literature.

Earth Dam Projects. By JOEL D. JUSTIN, M. Am. Soc. C.E. London: Chapman and Hall, Ltd. 1932. Price 31s. net.

MANY engineers will agree with Mr. Justin's view, as expressed in his brief introduction, that in some cases in which masonry dams of the non-overflow type have been built, an earthen dam would have performed the same function at a much smaller cost; also that it is possible to design and build an earthen dam for almost any given site and conditions of foundation, utilising available materials throughout a very wide range of sizes and physical characteristics. In view of the high degree of responsibility borne by the engineer in this class of work, Mr. Justin's painstaking and illuminating presentment of principles and methods will be welcomed. It embodies a large amount of precise information relating to successful and unsuccessful works, and presents some of the more important data relating to the physical properties of the materials used. In the light thus afforded, it interprets the natural laws governing water-earth relations in an earthen dam and in its foundations and surrounding strata.

In a chapter on sub-surface investigations, the more important typical conditions are briefly discussed, and the principal operations described. A useful feature is a description of the apparatus and method employed in determining by water pressure the location of open seams and the degree of water-tightness of the rock. Explaining the use of well-drilling apparatus for boring through the softer strata, the author describes diamond drilling, and declares it to be the accepted and best method of exploring rock. He makes no reference to the chilled shot apparatus, nor to losses of diamonds.

In the chapter on materials and laboratory tests, methods of laboratory control are explained, the testing of porosity and of permeability described, and the significance of the colloid condition of a material usefully discussed.

Questions of design are very clearly discussed in four chapters. The first, on general considerations, includes studies of the effects upon the line of saturation of different arrangements of the natural and placed materials, pervious and impervious, and of various dispositions of the core wall. The flow of water through soils, and the line of saturation, are further considered in the next chapter, which is followed by a discussion of slopes and of free passage of water, the series concluding with a chapter on piping, the effects of sheet piling, and the allowance for freeboard. This presentment of investigation and design is followed by an exposition of the three principal methods of construction, in rolled layers, hydraulic, and semi-hydraulic. Examples of works, under each of those heads, are given in the three concluding chapters. In many cases the author has furnished very useful descriptions of the conditions at the site, the materials of which the dam was built and interesting details of the methods followed. Two of thirteen descriptions of dams built in layers relate to British dams—Talla and Yarrow.

Whereas in some books of this class the subject is presented, as it were, in steps represented by the chapters, the analogy in this case is that of a smooth curve, leading up to typical works. The curve may be regarded as beginning, below the zero line, with the first chapter, in which the author describes and discusses twenty-six failures of dams, including two partial failures during construction. This discussion provides valuable information bearing upon the expositions of theory and practice which follow. Considerable space is devoted to the failure of the Melville and Horse Creek dams, to the slip that occurred during the building of the Calaveras dam, and to the partial failure of the dam at Necaxa. Expressed in percentages of the 102 cases which he has tabulated, the author's conclusions as to the causes of failure differ from those as stated in the report. He attributes larger percentages to leakage along the conduit, other leakage and overtopping, and considers that "slides" accounted for 5, not 15, per cent. as in the classification of the engineers of the West Virginia Power and Transmission Company in the report cited, which is that of the Hydraulic Power Committee, September, 1930, of the Pennsylvania Electric Association.

For British engineers, a comparison between this table and the author's other table of successful dams, may be interesting. Of 102 failures, nine were in countries other than the United States, these nine including two in Canada, and one each in England, Wales and India. Of the 131 tabulated cases of successful works, 34 are in countries outside the United States, including ten in England, five in Scotland, five in Ireland, two in Wales, and eight in India.

It is necessary to point out that Mr. Justin fails to furnish adequate and reliable guidance in respect of one vital factor affecting design, the estimation of flood flows. In the first place, he fails to present the method of direct computation from rainfall maps and curves of run-off percentages. In the second place, the basis of estimation which he puts forward, Fuller's formulæ and tables, is neither adequate nor reliable, as witnessed by Hazen ("Flood Flows"), who concludes that the indications are ". . . that the Fuller factors for maximum rates of flow should be limited to eastern [U.S.] conditions, and should not be used in the west." American engineers are at a disadvantage in dealing with the comparative data of floods, in that they believe that relations between maximum flows may usefully be expressed in cusecs per square mile. Another weakness is attributable to the conception of the maximum flood as related to the average flood, whereas no common logical basis can be found for the definition or classification of average floods. As regards the cusecs per square mile basis, the author states that for streams having catchments of more than 1000 square miles, there are not many actual flood discharges exceeding 50 units, cusecs per square mile, adding in a footnote that in the New England flood of November, 1927, the discharge from some such catchments exceeded 100 units. Reference to Baker and Conkling's "Water Supply and Utilisation," provides the examples:—In California, 1200 square miles, 92·5 units; 1900 square miles, 99·5 units; 3071 square miles, 94·4 units; New Mexico, 1480 square miles, 105 units; Texas, 7010 square miles, 92·3 units. For portions, diminishing towards 1000 square miles, of the larger of these catchments, the run-offs were presumably very much greater than those of the whole catchment. Hazen (*op. cit.*) gives for three catchments of the Miami River, 2937 square miles, 130 units; 2722 square miles, 94 units; 1128 square miles, 113 units.

With this reservation, as regards the matter relating to maximum floods, this well-written and usefully illustrated volume may be commended to engineers concerned with the design or building of dams, of any class, as being both an exposition of principles and a review of practice, the latter duly related to the former by comment or criticism. The very large amount of precise information relating to successful and to ill-fated works would alone render the volume of great value as a work of reference.

BOOKS RECEIVED.

Willis's Workmen's Compensation Acts. By W. Addington Willis. London: Butterworth and Co. (Publishers), Ltd., Bell-yard, Temple Bar, W.C. 2. Price 17s. 6d. net.

A Concise Building Encyclopædia. Compiled by T. Corkhill, M.I. Struct. E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 7s. 6d. net.

Cylinder Bore Wear. Published jointly by the Birmingham Aluminium Casting (1903) Company, Ltd., and the Midland Motor Cylinder Company, Ltd., Birmia Works, Smethwick.

Explosives: Their History, Manufacture, Properties, and Tests. Vol. III. Second edition. By A. Marshall. London: J. and A. Churchill, 40, Gloucester-place, W. 1. Price 42s. net.

The Calculation of Heat Transmission. By Margaret Fishenden, D.Sc., and O. A. Saunders, M.A. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 10s. net.

Encyclopædia of Oxy-acetylene Welding. Volume I., Pipe Construction; Volume II., Construction of Apparatus and Containers. London: Raggett and Co., 30, Red Lion-square, W.C. 1. Price 10s. per volume.

The St. Lawrence Waterway Agreement.

THE St. Lawrence deep waterway—a ship channel from the heart of the North American Continent to the Atlantic Ocean—is to be constructed. Canada and the United States have concluded an outline of the necessary treaty; final terms have been settled; and the treaty is being prepared for signature at an early date. In the whole gamut of world engineering, the project will be second only to the Panama Canal. The project is described officially as a means of improving and cheapening transport for a large part of the North American Continent, and its execution will enable vessels now plying on the Great Lakes to reach the sea. Alternatively, ocean vessels will be able to penetrate the continent to the head of the Great Lakes. Combined with great navigational facilities, there will be a very substantial development of power. More than 5,000,000 horse-power of electrical energy will be made available. Of this total, 2,200,000 horse-power will be generated in the international section. Ontario will have the use of 1,100,000 H.P., and the United States, under the Boundary Waters Treaty, will have the remaining 1,100,000 H.P. In the national or purely Canadian section, lying in the province of Quebec, 3,000,000 H.P. will ultimately be developed. The Beauharnois power project, 30 miles from Montreal, will be utilised in the national section.

New works necessary to bring the deep waterway into being are:—(1) Compensation works and some further excavation between Lake Erie and Lake Huron. (2) Compensation works in the Niagara River. (3) Excavation of reefs and points in the Thousand Islands section of the St. Lawrence River from Lake Ontario to Chimney Point. (4) Two developments on the international rapids section, two canals, and a authorised diversion at Chicago was only a little over 4000 cubic feet per second, but the actual diversion, in violation of that treaty, has progressively increased to a little over 10,000 cubic feet per second.

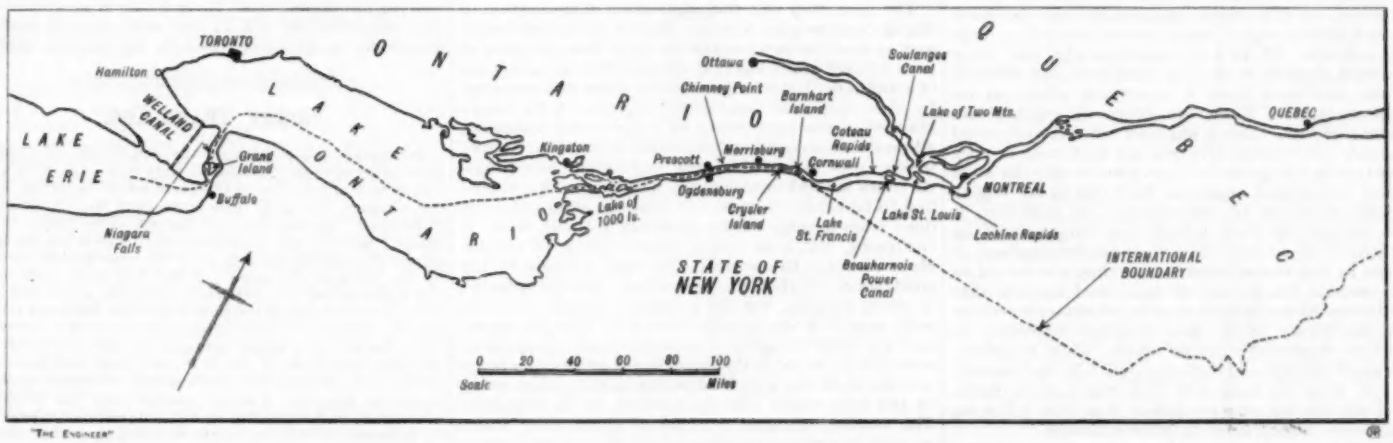
THE 27FT. SHIP CHANNEL.

The St. Lawrence deep waterway covers the project to provide a continuous passage by the construction of a 27ft. ship channel from Montreal to open water on Lake Superior, so that vessels operating on the Great Lakes can reach tidewater, and ocean vessels can, if desired, reach inland ports as far westward as Port Arthur, Fort William, Duluth, and Chicago. This project has been a cardinal feature of the policy of all Governments of Canada from the earliest times, and for generations there has been steady progress in the improvement of navigation. Channels have been provided at various times commensurate with the requirements of the vessels in use, until now little remains to be done to provide the 27ft. ship channel through the Great Lakes. Thus the problem is substantially that of dealing with the Montreal–Lake Ontario section of the St. Lawrence to link up the Great Lakes with tidewater.

Above Montreal, the first obstruction is the Lachine rapids. The present canal there is 8¾ miles long, and has a total lift of 46ft. The Lachine Canal gives access to Lake St. Louis and the next obstruction is found in the Cascades, Split Rock, Cedar, and Coteau Rapids, between this lake and Lake St. Francis, commonly known as the Soulanges section. The Soulanges Canal, begun in 1892, was completed in 1899, and is now in use. It has five locks and provides 14ft. depth of water. It is 14·67 miles long, and has a total lift of 83½ft.

Passing up through Lake St. Francis, a distance of 26 miles, one comes to the international section of the river, in which there is a series of canals. The first is Ontario—a conference between the Dominion and Ontario engineers was held. This conference reported in favour of the enterprise, harmonised Dominion and Ontario views and confirmed the preference for a two-stage development of the international section, a preference to which the United States authorities have conformed.

The 183 miles of the St. Lawrence River between Lake Ontario at Kingston and Montreal is for convenience divided into five sections, the first two of which are in the international section of the river between Ontario and New York State and the last three in the province of Quebec. The first section, known as the Thousand Islands section, embraces the deep lake-like reaches of the river, 67 miles in length, from Lake Ontario to the first swift water at Chimney Point, 3 miles downstream from Ogdensburg, New York, and Prescott, Ontario. The improvement of this section to the necessary depth does not entail a great deal of construction, involving only the removal of twelve reefs and the cutting back of four projecting points. This work is nearing completion and will enable the upper lake steamers, which can now pass to Lake Ontario through the Welland Ship Canal, to reach the present deep-water terminal at Prescott. The second, or international rapids section, embraces the 48 miles of rapids and swift water between Chimney Point and Lake St. Francis. The river here runs in a succession of rapids, beginning with the Galops Rapids and ending with the Long Sault Rapids, with a total drop of 92ft. The plan proposed for this reach of the river is the two-stage scheme. The first stage comprises a dam across the river at Crysler Island with a navigation canal and locks on the Canadian shore. These works will provide an average head of 24·2ft. in summer and 19·6ft. in winter, which will be utilised in two power-houses, one in the Canadian and the other in the United States channel, having a combined installation of 593,000 horse-power.



SKETCH MAP ILLUSTRATING THE ST. LAWRENCE WATERWAY SCHEME

total of three locks. Two power-houses with an aggregate installed capacity of 2,200,000 horse-power. (5) Dredging of shoals in Lake St. Francis. (6) Construction of locks at the lower end of the Beauharnois power canal. (7) Control dams and a canal with three locks from the foot of Lake St. Louis to Montreal Harbour, with a power-house at the foot of the Lachine rapids with a final installed capacity of 923,000 horse-power.

Unofficial estimates of the cost place the navigational expenditures at from 175 million to 200 million dollars, which, with the power expenditures, will bring the entire total up to 800 million dollars. In the division of costs as between Canada and the United States, it is reported that the basis will be a "fifty-fifty" one, with allowance to Canada for 120 million dollars expenditure on the Welland Canal and further expenditures, such as that on the St. Lawrence ship channel. A two-stage development will be carried out. Dams, it is stated, will be constructed at Barnhart Island and Crysler Island. Power will be available in the international section three years after work starts. The completion of all the navigational works required to permit ocean-going vessels to proceed through to the Great Lakes will take about seven years.

Before there can be any serious talk about beginning the construction, the treaty must be ratified by the Congress of the United States and by the Canadian Parliament. It is regarded as very doubtful if the United States Congress will be in a position to deal with the treaty this year, and the Canadian Parliament could not consider it until early next year, unless a special session is called before the end of this year. Canada, it is understood, has been exercising great care to have the safeguarding clause applying to the Chicago Drainage Canal diversion so worded as to leave no loophole or provocation for further dispute. While the Eastern States are quite agreeable to a treaty provision that will prevent any further injury being done to the level of the lower lakes, there is a lively sentiment in the State of Illinois, which is standing jealously on guard over the drainage canal. In the original waterways pact the at Cornwall. It is 11 miles long and has six locks with a total lift of 48ft. Next in order is the Farran's Point Canal, enlarged to 14ft. between 1897 and 1901. The canal is only about 1½ miles long with a lift of 4½ft. The Rapide Plat Canal at Morrisburg was first built for 9ft. draught at the same time as that at Farran's Point; the enlargement to 14ft. draught being carried out between 1884 and 1904. The last of the series of St. Lawrence River canals is the Galops Canal. The total length of this canal is 7·36 miles and there are two locks for up-bound and one lock for down-bound traffic, the total lift being 15½ft. The last canal being passed, one enters the Thousand Islands section, where there is ample depth for 14ft. navigation and where comparatively little work—already under way—requires to be done to provide a 27ft. depth. This section opens into Lake Ontario.

In 1920 both Governments referred the whole question of navigation and power in the St. Lawrence River to the International Joint Commission. One engineer representing each country was appointed to study the problem jointly, and they submitted their report, known as the Wooten-Bowden report. The Commission also held hearings in five provinces in Canada and in sixteen states in the United States, examining exhaustively into the economic features of the proposed waterway. Its report to the two Governments was entirely favourable, but recommended a further extended study. In 1924 an international "joint board of engineers" was appointed, consisting of six engineers, three being appointed by each Government. This board reported in 1926 and furnished supplementary appendices in 1927. The board exhibited general unanimity concerning the method by which the desired end should be attained, the only divergence being that, whereas the United States members of the board favoured a single-stage development of the international reach, the Canadian engineers were strongly in favour of a two-stage development. The matter was then referred to a Canadian advisory committee, which reported in favour of the project and finally—since the international section of the river, in Canada, lies in power. The second stage comprises a dam spanning the international boundary from the Canadian shore to the foot of Barnhart Island and from the head of this island to the United States shore. The deep-water canal proposed lies entirely in United States territory and has two locks. The average head available at Barnhart Island is 60·4ft. in summer and 56·4ft. in winter, and will be available for the production of hydro-electric energy in power-houses incorporated in the dam at the foot of Barnhart Island, having a combined installation of 1,607,000 horse-power.

ALL-CANADIAN SECTION.

The third, or Lake St. Francis, all-Canadian section comprises 26 miles of deep water through this lake, and the improvement proposed is the dredging of shoals so as to provide a suitable ship channel.

The fourth, or Soulanges, section embraces 18 miles of rapids and shoal water from Lake St. Francis to Lake St. Louis, with an average total fall of 83ft. The development proposed at this point is already well advanced by virtue of the new Beauharnois power development on the shore of Lake St. Louis, to which water is brought by a power canal from Lake St. Francis. This power canal has been designed to provide the required navigation facilities and will become available for this purpose when the required locks have been built. The initial power development at Beauharnois will be 500,000 horse-power. A final installation of 2,000,000 horse-power can be secured in this Soulanges section.

The fifth, or Lachine, section extends from deep water at the head of Lake St. Louis to Montreal and is 23 miles long and has a total fall of 48ft. The works contemplated consist of a control dam across the river at the head of Lachine Rapids, which will raise the level of Lake St. Louis sufficiently to provide navigation with comparatively little excavation through the lower end of the lake, which is at present a shoal. This dam would render necessary control works at the two northerly outlets of the Lake of Two Mountains to preserve the present distribution of the flow of the Ottawa River and prevent a reduction in the flow of

the St. Lawrence River past Montreal. From the foot of Lake St. Louis the canal would follow the north shore of the river to Montreal Harbour and contain three locks. The power development proposed will utilise only 30ft. of the total fall and will require a power-house at the foot of Lachine Rapids with a deep concrete-lined headrace canal on the south side of the river. The final installed capacity of this power-house would be 923,000 horse-power.

The Operation of Locomotives on Long Distance Haulage.

By J. G. B. SAMS, A.M.I. Mech. E., M. Inst. Loco. E.

In the early days of railways it was usual not only to allocate a particular engine to a particular crew, but, in addition, to reserve to the combination a particular "turn" of train working. Thus, for example, the "mail," the "London goods," or the "parliamentary," &c. &c., would always be worked by the same engine and crew. As matters progressed, however, better working was found in arranging a number of train-working "turns" suitable to a certain type of engine in a "link" and working them with a roster of engines with their regular crews, who would work each turn of the link in succession. Later on, it began to be thought that it was wrong to keep an engine idle because its crew were off duty resting, &c., so, where possible, a second crew was booked so as to "double-man" the engine, which would allow of the engine being kept in work for approximately twice as long as a single-crew engine, and a further extension of the same idea brought in the much discussed system of "pooling" the engine and crews. This system requires an excess number of crews over that of engines in the "pool," and consists of booking out the next available crew on the next available engine, quite a simple matter and on paper very sound economics, as the engine apparently can be kept almost continuously at work, and so compile a large daily mileage. There are, unfortunately, two other important aspects of pooling that were not foreseen at first, and that have a modifying effect on its economic value. They are costs of repairs and economy of fuel. Every engineer who has exercised authority over locomotive engines and men is very aware that it is impossible to get men to take the same interest in a pooled engine as they will in an engine specially allocated to themselves. In addition, it must be said on their behalf that they cannot be expected to do so well when they handle numbers of engines in any casual rotation, as they are bound to lack personal knowledge of individual engines that may be considered helpful or even necessary to economical handling. It remains therefore necessary to introduce improved systems which, while maintaining a good average daily mileage, will help and encourage the crews to keep fuel and repair costs down, and here readers are reminded that the following remarks are not confined to home railways.

The railway on which the writer is at present engaged lends itself very favourably to considerations of long haulage, as its main line is approximately 900 miles in length, and when he took over was divided into eight "lengths" of working, with nine running sheds fairly evenly spaced out. The engines were all pooled, and so were the nationalities (Europeans, Africans, and four castes of Indians) of the crews. Four classes of road engines of widely differing tractive effort were in use, which meant a great deal of remarshalling of trains at the engine-changing stations, and the whole system, while provocative of delays caused by unnecessary engine changing and train remarshalling, lent itself very favourably to locomotive failures *en route*, owing to jarring nationalities and lack of personal knowledge of the condition in which the engine was previously "put away." Failures have often occurred through the crew who put an engine away not reporting heating or even overheated bearings, &c., and, in fact, it is more than probable that to escape punishment crews have cooled journals down at the water crane just previous to putting the engine away in the shed. This sort of thing rendered detection of carelessness very difficult indeed, as the crew making the failure would frequently blame the previous man, and was certainly very bad from the point of view of discipline, as well as those of maintenance and running costs.

It is a very difficult matter to assess the average cost of a locomotive "failure," but the writer on his varied experience would put this figure at all events at not less than £50 for the primary cost (*i.e.*, for repairing the damage only), while the secondary cost (*i.e.*, delays to traffic, extra engines to move failed engine and train, &c.), may soar almost to any figure within reason, especially on a long single-line railway, over which crossings of trains may be affected, over the whole length by the failure, for a period of up to two days.

Owing, then, to these unsatisfactory features of pooling, it became necessary to take action, and at first a system of examining immediately on arrival in the shed was considered, but was turned down as expensive and not covering the point of lack of knowledge of the individual engine; that is, no amount of examinations would enable the examiner to pass the idiosyncrasies of that engine on to the next crew.

After some further consideration it was decided to make a test of a system of working which would limit the use of an engine to a double crew of the same nationality; the engine to run as many "lengths" as the coal capacity of the tender would allow, and the crews taking turn and turn of working the engine and resting in the train in a specially reserved compartment or vehicle, the change-over occurring at a predetermined point. A start was made with one engine and double crew, the engine belonging to the class that compiled the lowest mileage per failure, and consequently was the greatest nuisance about the railway, the train selected being the daily passenger train in each direction between headquarters and the coast, a distance of 330 miles (three lengths). This mileage may not appear to be very high, but it must be borne in mind that, owing to the hilly nature of the country and consequent lengthy and severe ruling gradients of 1 in 66, about eighteen hours are required to cover it, and in consequence the trial engine could only come on turn every third day. On arrival at the outward terminal, the engine was refuelled, and, owing to the bad quality of the water taken at sundry places *en route*, it was at first considered necessary to change the boiler water at the outward shed on every occasion. After about five hours in the shed, this short period being rendered possible by the ability to refill the boiler with practically boiling water, the engine was returned on the opposite passenger train to its base; later experience having proved that the round trip could be done without changing the water, this was stopped as a standard practice, and the engine worked the whole trip of 660 miles, covering approximately forty-three hours, in one steaming. The experimental system, after an extended trial, having proved successful, the working of the daily trains in each direction was later entrusted to a link of three engines of the hitherto unsatisfactory class, with three allocated double crews, with the satisfactory result that the delays and failures ceased, and the trains now run like clockwork.

The next step was the application of the system to the up-country mail service. Here it was found necessary to work in two lengths owing to the existance of even severer gradients (1 in 50) and the necessary use of a different class of engine with a lesser coal capacity. In this case the time-table, together with entire absence of the probability of boiler-water changing, allowed a much quicker turn-round (about four hours), which was a considerable operating advantage. At times an additional supply of a ton or two of coal had to be taken *en route*, but this was arranged to be done from a stage at the platform without delay to the train, the coal being placed ready in stacks. More recently the system has been applied to the goods service in the 330-mile section formerly operated in three lengths, but as a heavier engine than the mail engine is exclusively used with heavier trains, and the time occupied in running totals an approximate 24–25 hours, it has been found necessary always to start each run with fresh water in the boiler, owing to the bad water already referred to in this area. The service arranged consists of three daily trains in each direction requiring a link of nine engines to cover it, and it was thought desirable to give the engines not less than twelve hours at the home and six hours at the "out" base.

It may be remarked that there is an "economical" hot-water wash-out plant located at the headquarters shed, and all engines passing through the shed from down-country (the bad water area) are always washed out here. The engines on the up-country service, a better area for water and a shorter inclusive run (about 520 miles), run two trips per wash-out, which has been got down to a 2¼–2½ hours' operation, steam to steam, not too bad for native labour supervised by Asians. Dealing with coaling, the passenger engines run the 330-mile stretch without intermediate supply, but the goods engines have to call in at a depôt *en route* and take a few extra tons to see them through on the up journey only—this on account of severer gradients in the "up" direction.

The average fuel and lubricant consumptions of the engines employed in these workings have improved very materially as a result of the reduced number of lightings-up and the increased personal knowledge of the engines by the enginemen, the improvement figuring out at approximately 17 per cent. in each case. It must be remembered that every time an engine is put away it is not possible to prevent the oil in many of the lubricators, &c., from continuing to siphon away, with the result that prior to the next service all this waste has to be made good; also that every lighting-up occasions expenditure in fuel with no compensating mileage. Here the writer would venture to stress the real advantage and economy of enginemens' personal knowledge of, and interest in, their own engine.

It is, perhaps, too early to state with certainty the percentage of time gained *en route* with the goods service, but experience so far certainly justifies the figure of 10 per cent. due to less engine-changing and also to the fact that as no overtime can be made (crews change over at or about the expiry of their ordinary hours of duty) there is no inducement to "ca 'canny" along the road and so extend the hours of duty beyond the statutory period. It should be said that the guards (who now work on the same system) as well as enginemen, are paid on an unvarying monthly minimum plus a mileage allowance, plus again additional for overtime when worked. In the absence of possible overtime, there is every inducement to the freight train crews to get through as quickly as possible and not delay the train by slow shunting, &c.; the passenger trains, of course, running to a fixed schedule are not affected in this respect. Another advantage is the increase in average mileage per diem. In the writer's experience this has increased quite 50 per cent. in the case of the passenger engines, and may be expected to reach 30 per cent. in the case of goods engines, provided that the necessary traffic offers. This may be claimed as very satisfactory.

In conclusion, the writer ventures to think that pooling has, or has had, a bearing on the question of oil *versus* grease lubrication for locomotives. It would appear that owing to bearing, &c., troubles consequent upon general engine pooling it became advisable to divert as far as possible the lubricaton of the engine from the driving to the maintenance staff, and the only way apparent was by the use of grease cakes which would last out long mileages and could always be renewed in the sheds as required. It may be recalled that goods rolling stock in the past was always grease-lubricated, and the stiffness of haulage of a train of grease-lubricated wagons, compared with a similar train of oil-lubricated wagons, was well known to an older generation of enginemen. On this argument it would, therefore, seem that grease lubrication is rather a retrograde step. It is certainly far cheaper in first cost, but when we consider the increased resistance which must cause a heavier coal consumption, the additional maintenance labour, and the fact that when a journal starts to overheat lubrication cannot be accelerated to bring it round as with oil, and, consequently, there is every chance that the brass, as well as the journal, will be completely spoiled, oil properly applied would seem by far the most satisfactory and economical. As the system of working explained above avoids personal ignorance of a particular engine, and allocates it to a regular double crew, there would appear no necessity whatever to call in the maintenance staff to undertake duties better done by the running staff.

SIXTY YEARS AGO.

Scientific discussion and the acquisition of scientific knowledge were still hampered sixty years ago by a widespread lack of precision in the use of scientific terms. Take, for instance, the reply which we gave to "A Constant Subscriber" in our issue of August 16th, 1872. "The power," we told our correspondent, "will be as the space passed through by the men is to the space passed through by the point of the screw; if the men move 50ft. while the screw moves 1ft. vertically, then the screw will gain 50 to 1; one-third of the power must be deducted for the loss by friction." This misuse of the word "power" for "force" was quite common in the technical and scientific literature of the time, and may well have lain at the roots of numerous misbegotten attempts to realise perpetual motion. Further insight into the confusion of scientific understanding which then prevailed is provided in the same issue in the course of a leading article entitled "Heat and Steam." Notwithstanding all that Mayer, Rankine, Joule, and Clausius had done to instruct us, so we wrote, one or two propositions connected with heat and steam were still not generally comprehended. From that opening sentence the modern reader might expect to find that we were about to discuss certain aspects of the then comparatively new science of thermodynamics. It was not so, however. We were bent upon the exposition of the phenomena attending the transmission of heat and upon explaining the true meaning of the term "latent heat." In our treatment of the first-named subject, we mentioned casually Tyndall's theory of vibrations, and otherwise made it clear that we were aware of the fact that "heat is a mode of motion." Nevertheless, we apparently regarded that basis of approach to the subject as still too novel and abstract to appeal to our readers. At any rate, there is a strong flavour of the old caloric theory about our explanation of how heat released on the combustion of coal passed into the water inside a boiler. We began by stating that in a boiler of fair construction a pound of coal would convert 9 lb. of water into steam. These 9 lb. of steam would, we continued, contain between them a total of 6,720,000 foot-pounds of energy, or sufficient to raise 2232 tons 10ft. high. How, we asked, did the fuel in the furnace do this enormous amount of work on the water? There were three possibilities. The heat might be forced into the water by some special action on the part of the fuel, or be absorbed from the fuel by some special action on the part of the water, or find its way into the water by a combination of force on the part of the fuel and of absorption on the part of the water. The absorption theory, we said, must be absolutely rejected. Water did not absorb heat as a sponge soaked up liquid. A vast expenditure of energy was required to force even a single unit of heat into it. The heat required for evaporation found its way into the water by main force. Nothing seemed more startling than the fact that the volatile products of combustion in their rapid flight to the chimney should be able to perform the enormous duty implied by the act of evaporation. There we left our explanation of the transmission of heat. It must have puzzled many of our readers as much as the arithmetic on which it was founded puzzles us to-day. Our discussion of the term "latent heat" turned upon the familiar argument that there is no such thing as latent heat and that what is stored up in steam is not heat, but work.

The Southern Pacific Railroad is very proud of the fact that not a single passenger has been killed in a train accident on that system for a period of twelve years.

New Coaling Plant for the L.N.E.R., Hull.

On page 160 we illustrate a new locomotive coaling plant which the London and North-Eastern Railway Company has recently installed at its Botanic Sidings, Hull. The plant, two views of which are given in Figs. 1 and 2, was designed and manufactured by Babcock and Wilcox, Ltd., of Renfrew and London, and it consists essentially of an electric hoist, by means of which standard railway wagons are lifted to a suitable height and then tipped, so that the contents are discharged into an overhead bunker constructed of reinforced concrete. The coal is drawn off from the underside of the bunkers and discharged into the locomotive tenders by means of automatic feeding and measuring devices.

The wagon hoist is designed to deal with coal trucks up to 20 tons net capacity, or 30 tons gross, at the rate of eight per hour, thereby having a maximum capacity of 160 tons per hour when dealing with the largest wagons. A steel-framed cradle fitted with a tilting platform is provided to receive the wagons, and this cradle is hoisted in steel guides by means of wire ropes connected to the electrically operated hoisting winch, which is arranged over the top of the bunker structure.

The winch illustrated in Fig. 3 is provided with twin barrels, which are grooved to receive two hoisting ropes and two balance-weight ropes. The balance weights are of cast iron and are mounted on runner wheels which operate on rails attached to the concrete bunker structure on the opposite side to the main hoist. The arrangement of the wagon guides and balance weights is clearly indicated in the Figs. 1 and 2 on page 160.

Immediately the hoisting operation is begun the cradle platform tilts over and allows the wagon to rest its side gently against a side buffer beam. The cradle with the wagon is then lifted to the required height, the top of the wagon coming into contact with an overhead clamping bar, coupled by means of levers and ropes to counterweights, so that the clamping bar is held against the top of the wagon with sufficient force to retain it rigidly in position on the cradle during the tipping operation.

The hoisting ropes are arranged in quadruplicate, each pair being compensated in such a manner that in the event of any one rope breaking, the remaining ropes will sustain the load, the main balance-weight ropes being arranged in a similar manner.

The hoist, which is operated by means of a 50 H.P. reversing motor of the enclosed ventilated type, is controlled by an upright tramway type controller housed in a concrete control cabin adjacent to the foot of the hoist. Limit switches are provided to prevent overwinding in either direction, and are actuated by means of a roller chain and screw-operated tappets from the main hoisting winch.

The coal bunker has a capacity of 250 tons of coal, and is provided with two outlets in the flat bottom furnished with rack-operated valves. The bunker, supporting columns, and the superstructure carrying the hoisting gear, are constructed in ferro-concrete, the whole structure being carried on concrete piles, which were arranged in groups of four and six, the average depth of the piles being about 25ft. The concrete work and foundations were carried out by the Allen Construction Company, Ltd., of Glasgow, acting as subcontractors to Babcock and Wilcox, Ltd.

The whole of the structure above the bunker is enclosed with concrete panels, except the opening required at one side for discharging the wagons, and a similarly constructed housing is provided over the hoisting gear, outside access ladders being provided thereto from the ground level.

Under the bunker a concrete platform is arranged to carry the two measuring feeders, this platform being formed integral with the main structure. A view of the feeders is reproduced in Fig. 4. The measuring feeders are of the apron type, each designed to discharge coal at the rate of 3 tons per minute into the locomotive tenders standing on the track underneath. The feeders are driven by means of two 5 H.P. motors with worm and spur reduction gear, and are provided with meters and control gears of the Lea Recorder Company's latest design, with visible indicators showing the weight of coal as delivered to each locomotive, while, in addition, a total quantity counter is provided, giving the aggregate amount of coal delivered over a period of time. A lever-operated mechanism is provided for setting the locomotive number which is then automatically recorded, together with the weight of coal delivered, and the time, on a strong paper tape, the whole mechanism being interlocked with the feeder driving gear and operated by means of push buttons. Bifurcated delivery chutes are provided under each feeder discharge, complete with deflecting valves, in order to distribute the coal in the tenders, and, in addition, water sprays are fitted in the chutes to wet the coal, if necessary, as it is discharged. A timber platform runs under the bunkers alongside the locomotive road, arranged at a suitable height for the firemen to step off their engines, and on this platform two cabins are provided to house the feeder control gear and the coal-measuring and recording apparatus, so that the actual work which has to be done by the engine men is reduced to a minimum and the filling of tenders carried out with accuracy and expedition.

THE first direct shipment to England of Ford V-8 cars, manufactured at the East Windsor plant of the Ford Motor Company of Canada, went forward by the s.s. "Tractor" on July 20th, *viâ* the St. Lawrence waterway to Dagenham. The shipment consisted of 220 cars. The s.s. "Tractor" is specially fitted as a garage ship, and the cars were delivered at the dock under their own power. A special elevator, located on the starboard side of the ship, carried the cars from the dock to the upper deck, and a ship's elevator from that deck to the three lower decks. The cars were secured by chocks for the inland water trip and will be lashed for the ocean voyage. The entire trip is expected to take twenty days.

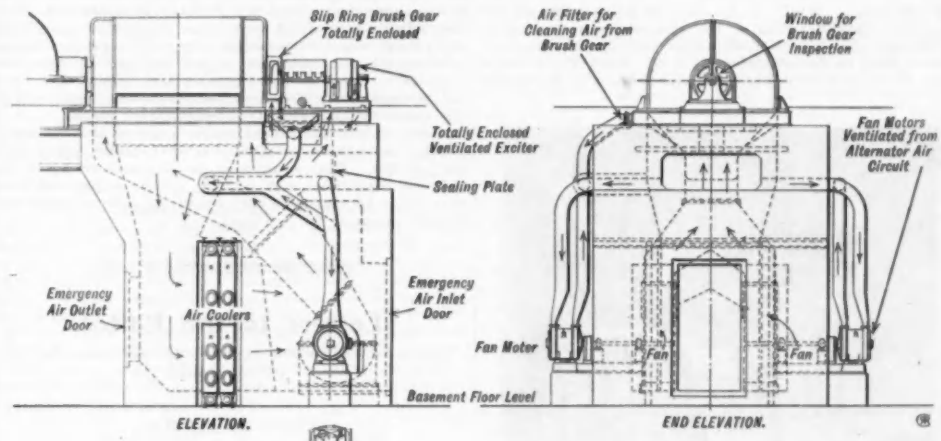
Developments in the Cooling of Parsons' Turbo-Alternators.

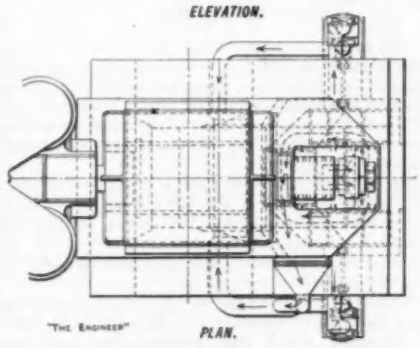
WITH the introduction of the closed air circuit ventilating system on turbo-alternators important advantages were gained and central station engineers were relieved of much responsibility. The periodical cleaning of the machines, which were sometimes unable to carry their full load on account of the ducts being choked with dirt, became a thing of the past, and the risk of damage caused by the sand blast action of the dust in the air was removed. Other advantages of the closed system are a great reduction in the noise, and by reason of the limited amount of oxygen in the ventilating passages the prevention of damage by fire in the event of a short circuit. The introduction of the scheme of using the same air continuously was no doubt retarded by the belief that adequate coolers would be very large and costly, but experiments carried out by C. A. Parsons and Co., Ltd., indicated that by using grilled tubes it was possible to house the whole of the cooling equipment in the space available under the machines. The first commercial turbo-alternator with these coolers made in the Heaton works was a 3000-kW unit, which was installed in 1919 in the Blaydon station of the Newcastle-on-Tyne Electric Supply Company, long noted for its policy of rapidly taking advantage of new developments.

For a long time after the introduction of the system it appeared that nothing more remained to be done in connection with the ventilation of turbo-alternators or at any rate as long as air remained the cooling medium, but in due course it was deemed desirable to include the slip rings and exciter in the ventilating system and thus protect them from the dirt and dust of the atmosphere. By this improvement Messrs. Parsons have carried the principle to its logical conclusion by providing protection and permanent cleanliness for the complete unit. The three 50,000-kW Parsons turbo-alternators for the Dunston power station are built on these lines. As shown in the accompanying engraving, two main air circulating fans are provided on each machine, each of sufficient capacity to enable the alternator to carry a continuous load of 40,000 kW with the other fan out of service. The machines are thus capable of working at any load up to the most economical load with a single fan and under normal conditions with both fans running the ventilation is claimed to be extremely efficient. Together with the duplicate air coolers, both fans are housed within the foundation block and the coolers can easily be withdrawn for inspection. Apart from saving space, the arrangement permits of a much more direct and efficient discharge of the air from the fans than is possible when they are placed outside the foundations. It also reduces the volume of air in the system and thus increases the security against fire.

As shown in the drawing, the fan motors alone are in the basement and the space they occupy is insignificant. The fan bearings are in a recess and can easily be inspected without the attendant having to enter the air chamber. Like the exciter and slip rings, the fan motors are ventilated from the main air circuit and are consequently protected against dirt and dust like every part of the alternator. The cooling air for the exciter is drawn from the main circuit by means of a fan on the armature, and after it has passed through the core and windings it travels over the commutator. It is then led by a duct in the bedplate to the slip rings and brushes of the alternator rotor, and after passing through a small viscous air filter, which is arranged in sections which can easily be removed for cleaning, it is returned to the main air circuit for recooling. The small filter is provided to ensure that the air is always quite clean and free from any trace of dust from the brushes.

The specification for the 20,000-kW 33,000-volt turbo-alternator under construction at Heaton for the Electricity Commissioners of South Africa calls for the ventilation of the exciter and slip rings in accordance with the Parsons method.



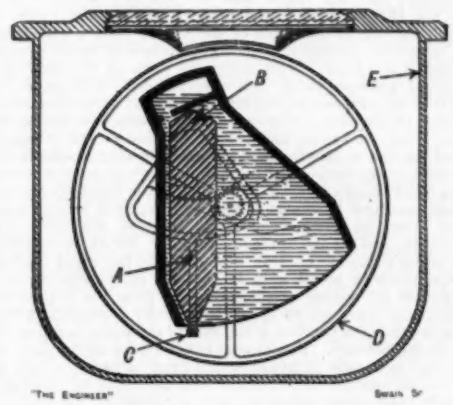


50,000-kW AIR-COOLED ALTERNATOR

Testing of Motor Car Brakes.

ALTHOUGH machines have been demonstrated for the testing of motor car brakes wheel by wheel in a garage, and although several such machines have, we believe, been installed, very little attention has been directed in this country to the actual testing of braking efficiency on the road. Several countries, however, have by law imposed limits of braking efficiency which must be complied with. The greatest activity in this direction is shown in Canada and the United States, but Norway and Holland, among European countries, have set up standards. In this country the police are at liberty to call upon a motorist to demonstrate that the brakes of his car are efficient. The importance therefore of obtaining an accurate instrument by which that efficiency can be measured cannot be gainsaid. At present the usual method followed is to determine in what distance a car can be pulled up if it is originally travelling at 20 m.p.h. The difficulty of determining the exact moment at which the brakes are applied in conjunction with the considerable errors introduced if the road surface is not absolutely level makes this method rather approximate. It is not impossible that in the future a legal standard of braking efficiency may be enforced in this country, as it is elsewhere, and in that case the importance of obtaining an accurate standard of measurement will be considerable.

There has been introduced by Tapley and Co., of Southampton, the decelerometer suitable for brake testing which is illustrated by the accompanying diagrammatic line engraving. It consists of a pendulum A suspended upon pivots at B, and enclosed in a suitably shaped tank containing a liquid by which movements caused by a bumpy road or the swaying of the vehicle may be damped out. The pendulum is made of steel and is permanently magnetised. The bottom of the tank enclosing it is made of thin brass plate curved in an arc of a circle, so that the free end of the pendulum always remains close to it, however great the swing. Outside the base is a light armature C, which is held adjacent to the end of the pendulum by magnetic attraction, and consequently follows its movements. By means of a toothed segment and pinion, the movements of the armature are communicated to the drum D, the position and reading of



DECELEROMETER FOR TESTING BRAKES

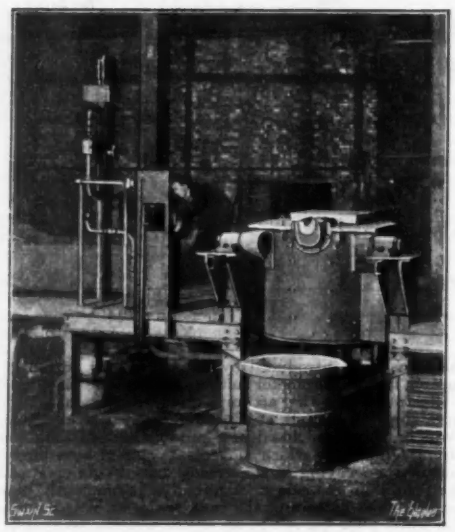
which can be seen through the window of the enclosing base E. Deceleration of the car tends to cause the pendulum to swing forward and so rotate the drum. A scale-retaining mechanism is incorporated in the design, so that the maximum reading may be obtained without close scrutiny of the progressive movements of the scale. The instrument is supplied with a clamp mounting, by means of which it can be rapidly attached to the running board of the car.

The firm also makes an indicator that can be fitted to the dashboard of the car, and which will show the driver whether the brakes are working efficiently or otherwise. This instrument operates upon a different principle. There are within it three tubes shaped much like a chemist's test tube. Each is supported on a pivot near one end, the other end being free to move, but resting against a pin. The pivoted end lies towards the front of the car and the tube is set at a small angle to the horizontal. Each tube is inclined at an angle different to those of the other two. The lower or free end of each tube is closed by a cap, the outside of which is brilliantly coloured, to act as a signal, and each tube contains a ball, which, of course, normally remains at the lower end. When the brake is

applied, however, the ball tends to run up the sloping floor of the tube. If it does so and reaches the further end, the balance is disturbed, and the tube swings about the supporting pivot until its free end is opposite an opening in the dial of the instrument, where, owing to its brilliant colouring, it is easily observed. Since the three tubes are originally set at differing angles, different degrees of brake efficiency are necessary to operate them, and thus the instrument is able to indicate whether the brakes are operating inefficiently or satisfactorily. The tubes remain in the tilted position until reset by the movement of a small lever at the side of the instrument.

A New Induction Furnace.

A party of steel experts from various parts of the country recently attended a demonstration at Newcastle of steel melting by means of an induction furnace made by the General Electric Company, of Magnet House, W.C. 2. Although many induction furnaces are now in use and their principle of operation and advantages are well understood, their manufacture has hitherto been undertaken by a very few British firms. The new G.E.C. furnace shown in the accompanying illustration is made under the Stobie patents, and its construction differs from that of other furnaces, which heat the metal by induction. While it is claimed to possess all the desirable characteristics of the coreless type, by reason of the fact that it is partially cored, the current consumption is said to be exceptionally low. With the average rates for electric current in industrial districts steel superior



Electric Induction Furnace

in quality to the best crucible steel is claimed to be produced at approximately half the cost of that of the crucible process. The makers explain that while in an ordinary induction furnace the magnetic field has to force its way through the air inside and around the inductor coil, in the G.E.C. furnace the path of the magnetic field is through thin laminations of special alloy steel which has a magnetic conductivity several thousand times greater than that of air. This magnetic path is brought to a central position inside the inductor coil, and the result is that an intensely strong and centralised field is produced inside the crucible. The construction permits of the exclusive use of iron and steel to encase the furnace, and as the magnetic field is concentrated towards the centre, stray fields outside the inductor coil are reduced to negligible quantities. Little attention is required beyond that involved in charging and pouring, and labour costs are therefore low. Automatic control simplifies the process and is recommended. The speed of melting is under complete control, and owing to the rapid melting permissible a small unit is capable of a large output. Another advantage of the induction principle is that the steel and other alloys are melted under conditions which ensure that the product is the sum of the materials charged into the furnace. The charge cannot take up sulphur, as it does in a coke or producer-gas-fired furnace, or carbon, as in an electric arc furnace, and injurious non-metallic oxide and slag inclusions are eliminated. When the metal is molten an automatic stirring effect is produced, which ensures uniformity of composition throughout the charge.

Photo-Electric Control Equipments in Tube Mills.

In the works of Stewarts and Lloyds, Ltd., Osram photo-cell equipments are serving a useful purpose in connection with the manufacture of welded steel tubes. From the moment when the heated strip from which the tubes are rolled is removed from the furnace at a temperature of over 1350 deg. Cent. to the end of the process, when the finished tube moves down the cooling rack at the other end of the tube mill plant, very rapid handling of the material is necessary. Usually the tubes are from 15ft. to 18ft. long, and the time interval between the rolling operations, with the most up-to-date process, is a matter of a few seconds. After a tube has passed through the sizing rolls it runs at a considerable speed down a trough, and is automatically transported to the cross rolls for hot straightening. When it has passed the cross rolls it moves on to a cooling bank and drops into a collecting cradle from which it is taken with other tubes to the finishing shops by means of transporters.

Owing to the rapidity with which the tubes follow one another through the sizing and cross rolls, the operation of releasing them from the cross rolls in order to allow them to pass to the cooling bank demands very prompt action on the part of the operator, for the distance between the tail end of one tube and the nose of the next tube following it is often only about 3ft. The slightest error on the part of the operator in timing will result in collision between the tubes, and a temporary interruption in the work. Mechanical means that have been devised to check these operations and to prevent the tubes from colliding or being sent forward into the cross rolls before the preceding tube has made the requisite movement are said to have failed. Levers and other arrangements that were struck by the hot tubes travelling at great speed were quickly damaged, and the equipment became ineffective.

Investigations carried out by the General Electric Company showed, however, that the ray given out by the hot tubes would operate a photo-electric cell placed within a few feet of them, and the possibility of controlling the movements of the tubes by means of these cells therefore became apparent. After amplification by means of a valve and relays, the current set up in the photo-electric cell is made to operate an electrical contactor, which closes the circuit of a powerful solenoid, by means of which the releasing shutters, originally operated by hand, are now automatically operated at the correct moment. Collision of the tubes is therefore prevented, and at the same time the tubes are counted by means of another photo cell equipment, which operates an electrical counter. Optical warning signals, consisting of red and green lights, also indicate to men at the furnaces and racks when it is safe to send another tube or when the passage is obstructed. By means of photo-electric temperature recorders, it is possible to test the actual temperature of the hot strips leaving the furnace or that of a tube during any part of its journey. The equipment is designed to meet the arduous conditions met with in rolling mills, and with current at 1d. per unit the cost of the current consumed is approximately 2d. per week.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STATIC BALANCING.

Sir,—The most interesting article on "Static Balance of a Shaft with Skew Stiffness," which appeared in The Engineer of August 5th last, described and illustrated in Fig. 5 a static balancing machine said to be a rough model of the "Martin" balancing machine. It is just as well to point out here that this only represented a very rough approximation of the latter.

To touch only upon one or two points in support of this: Not only is the free end of the rotor shaft borne in a universally movable suspended frictionless bearing in the "Martin" machine, but its near end, resting on the beam, is supported in a special manner, ensuring absolute endwise location without restricting the beam movement. Where the author suggested the use of circular supporting rails for a shaft, to be consequential he should use these at both its ends. His V hole, however, has flat sides. What happens when the beam dips at this V hole side? The shaft will then be supported at the front edge of the V sides, and conversely when the beam rises the shaft will bear on the back edges of these V sides. At the same time, its back end will roll slightly forward towards the beam over the circular support rail, and conversely roll backwards over this rail when the beam rises. As a result, the distance between the rail support and the beam is appreciably increased, while the distance between the rail and rotor carried on the shaft centre is decreased, and conversely. The actual loading of the beam will be appreciably affected thereby, and where the machine depicted is intended to measure the torque set up by the unbalance, which is at best a very small value, the relatively large error set up by this faulty method of supporting the shaft will completely overshadow the small torque we are supposed to be able to indicate in this manner. It follows that any reading obtained is a composite and erroneous one, and certainly not the small torque caused by static unbalance which the author set out to measure.

To obtain accurate readings, it is, moreover, imperative that the centre line of the shaft axis and the horizontal through the beam fulcrum at zero—*i.e.*, equilibrium position—should lie in the same horizontal plane to ensure great accuracy in the readings while the distance from the V hole to the fulcrum should be a minimum, leading to sensitiveness.

In the "Martin" machine the ratio between the distance from the V hole to the fulcrum and the opposite lever arm of the beam is very large, say, 1 : 250. In Fig. 5 this distance relatively to the beam arm L is only about 1 : 3. As a result in a 3000 grammes rotor of a gyro-compass of 5½in. diameter, an excentricity of only 0·0012 mm. (approximately 1/20,000in.) could be easily detected on a "Martin" balancing machine, and the unbalance moment corrected. Likewise, in a 10-ton turbine rotor excentricities of 1/40,000in. and less are indicated, enabling the corresponding small unbalance moment to be corrected. (See "Notes on Balancing Rotating Masses," by J. W. Rogers, *Mechanical World*, February 10th and 17th, 1922.)

The author also referred to Limitations of Static Balance. It may not be out of place here for those who are interested in balancing in general to mention the importance of static balancing and some of the advantages offered by its use. Its importance for high-speed rotational work is mainly due to the fact that any initial excentricity of a rotor is magnified by the elastic flexure of its shaft. To avoid undue magnification, shafts are usually designed so that the "primary" critical whirling speed lies at least 20 per cent. above the highest running speed; but a smaller margin may suffice if the rotor is well balanced, and a larger margin may be necessary if the static balance is unsatisfactory. In actual practice, it is found that only a few rotors require expensive dynamic balancing, as an extra refinement. The large majority only require static balancing.

On further consideration it will be found that the 20 per cent. margin between the running speed and the critical speed is required to cover not only any uncertainty in the calculation of the true critical speed, but also an allowance of imperfections of balancing. It should be remembered that the whirling speed at which dynamic unbalance first makes itself really evident always lies far above the better-known critical speed at which static unbalance produces dangerous effects, although dynamic unbalance does not. For rotors which have to run at 70–80 per cent. of the well-known critical speed, it follows that static unbalance is liable to be magnified while dynamic unbalance is not. Hence, the greatest care should be exercised to eliminate static unbalance from such rotors, but dynamic unbalance may often be disregarded. (For fuller information on these facts, see B. P. Haigh, D.Sc., "The Static Balancing of Rotors," The Engineer, Vol. 145, March 23rd and 30th, 1928.)

Modern high steam temperatures also demand more careful static balance of turbine rotors for the following reason:—The critical speed in such cases for the shafts is generally taken to lie about 25 per cent. above their running speed when designing them, for reasons already stated above. Their bearing loads depend upon the ratio of running speed to critical speed. The more, therefore, initial excentricity is reduced, the closer one can run to the critical speed. We are told that with the increase of steam temperatures, now so prevalent, the coefficient of elasticity, with Young's modulus of steel, decreases as the temperature rises, and the critical speed of any part is affected by the decrease in elasticity. In a specific instance for a certain high temperature installation, the critical speed of the turbine rotor would have to be allowed for as lying 36 per cent. above that of the running speed at 60 deg. Fah.

In such cases it becomes vitally important completely to eliminate any initial excentricity, as thereby an appreciable reduction in this percentage margin is made possible, thus reducing the bearing loads and offering one of the best preventive measures for overcoming tendencies leading to these troublesome, often dangerous, and always costly vibration effects. It is here that static balance is of such importance, and materials showing increased rigidity and strength at high temperatures will prove welcome.

W. Hamilton Martin, M.I.N.A.

London, N.W. 3, August 10th.

THE LEICESTER AND SWANNINGTON RAILWAY.

Sir,—Circumstances having prevented revision of last week's article before going to press, may I add the following notes?

Messrs. Robert Stephenson and Co. have now no original record or drawing of the old winding engine at Swannington, but, in all the circumstances, there is every probability that tradition correctly ascribes it to their manufacture.

Mr. Alfred Whitaker, a director of the neighbouring Whitwick Colliery, informs me that the district pumping engine, which to-day is served by the old winding engine, is also remarkable for its time. Built by Robert Stephenson and Co. in 1876, it is a tandem compound, with H.P. cylinder 42in. diameter, L.P. cylinder 72in. diameter, by 8ft. stroke; boiler pressure 60 lb. Working at 6 r.p.m., it lifts about 8 tons of water per minute from a depth of about 87 yards.

Regarding the geological conditions mentioned in the article, a description and plans of the similar volcanic phenomena in the Coaley Hill Dyke, near Newcastle, will be found in Greenwell's "Mine Engineering" (1889), page 102, Plates 23 and 24.

The original letter quoted, referring to labour difficulties, was dictated, not written, by George Stephenson, whose holograph letters are rare and remarkable for their peculiar phonetic spelling. Most of his letters which have been preserved are dictated.

The Writer of the Article.

August 8th.

ACCELERATED TRAIN SERVICES.

Sir,—Reference has been made in your columns of late to accelerated train services on several of the main lines, and it would be interesting to know what additional work, if any, this means in the way of more frequent, and possibly more extensive, overhauls of the engines.

These higher speeds must also entail a greater strain, both on the driver and fireman. How do they regard the accelerated services, and do they have just the same working hours as men on the slower trains?

I have no doubt some of your readers will be able to throw light on these interesting aspects of the speed question.

August 8th. F. N. B.

South African Engineering Notes.

(*By our South African Correspondent.*)

More Generating Plant.

THE rapid increase in the consumption of electricity in Cape Town and the adjoining areas extending as far as Stellenbosh and Paarl, about 40 miles from Cape Town, served by the Dock-road power plant of the municipality of Cape Town, and the Salt River power plant of the Electricity Supply Commission, which are at present operating in parallel, had rendered it plain some time back that one or other of the two plants must be increased to meet the increasing load. Negotiations between the City Council and the Electricity Commission have been proceeding during the past twelve months, the final outcome of which has been a decision to augment the generating plant at the Salt River power station 2 miles from Cape Town, and to have the new plant in commission by the winter of 1933. This plant will comprise one 20,000-kW turbo-alternator, four new boilers, E.H.T. and L.T. switchboard and transformers. C. A. Parsons and Co., Ltd., are the contractors for the new generating plant, an interesting feature of which is that the alternator will generate at 33,000 volts direct. It will be on the same principle as the machines working at this pressure at Brimsdown, and will be the first of this voltage to be used outside the United Kingdom. The Salt River turbine will be a single-cylinder machine, with duplex exhaust, similar to that at Derby, and designed for a steam pressure of 400 lb. per square inch at the stop valve, a temperature of 750 deg. Fah., 28·8in. vacuum, and a speed of 3000 r.p.m. The two-stage tap-off feed heating will give a feed temperature of 250 deg. Fah. The condenser will consist of a mild steel fabricated unit. The 50-cycle, 33,000-volt alternator, with a closed system of cooling and direct-coupled exciter, will give 20,000 kW at 0·8 power factor, the most economical load of the set being 16,000 kW. The steam-raising plant will comprise four Babcock and Wilcox units, each having a normal economic output of 100,000 lb. per hour, and a maximum continuous output of 131,000 lb. per hour. Each boiler will be equipped with a Babcock chain grate stoker, 18ft. 6in. wide, and 16ft. long.

Tractors in Southern Rhodesia.

A prominent farmer in Southern Rhodesia draws attention to the fact that of the several makes of British tractors which have at one time or another been on the Rhodesian market, none appears to have been suited to the conditions, with the possible exception of the latest and newest, which, owing to its appearance just before the slump in commodity prices, has not yet had a fair chance. But even this tractor embodies several features which have made the other makes of British tractors unpopular. These disadvantages reside in the small bore, long stroke, and high speed of the engine. In the farmer's opinion the American practice of large bore, comparatively short stroke, and low-speed engine is more suitable. One of the most important points to be considered is that of cooling. Working as it usually does at a temperature of 120–130 deg. Fah. in the sun, on the fields, the life of the tractor in Rhodesia is "one long boil." It must also be borne in mind that field work for a tractor in hard sun-baked lands, with stumps, roots, and stones dotted here and there, is a series of bumps and jars, more or less severe. The question of utilisation of maize cobs—that is, the core on which the corn grows—is also worth consideration by tractor manufacturers. The use of suction gas, however, appears to be the real solution of the problem. The railage on a case, containing 8¼ Imperial gallons of paraffin, coming into Rhodesia is between 4s. and 6s., according to the distance, and the average price of paraffin landed on a Rhodesian farm can be taken to be 2s. per gallon, or a little more, 2 gallons at least being required to plough an acre of land. It would appear that in the provision of a satisfactory suction gas tractor there is a great opportunity for the British manufacturer. What appears to be wanted is a well-built tractor of about 40 H.P., with large bore, comparatively short stroke, and a low-speed engine, with two—or better three—gears forward, and one reverse; and equipped with a gas producer which does not generate enough heat to incommode the operator. The track should be able to clear the rows of the main crops of Central and South Africa, in the case of maize, 36in. to 42in., or, better still, the track should be adjustable, and with a short wheel base enabling a turn in a radius of about 12ft. Above all, of course, is the necessity for a reasonable price. There is no country in which the development of English agricultural machinery is more sympathetically watched than in Rhodesia, or where English tractors would be given a fairer trial. If the English makers supplied a tractor on the lines indicated they would be sure of a demand from all the Colonies in South and Central Africa at least, and probably in Australia, where a considerable amount of experiment in suction gas has recently take place, and possibly in Canada as well.

Northern Rhodesia Copperfields.

Those who have not visited the copperfields in Northern Rhodesia cannot realise what has been accomplished, and the great potentialities for the future. It is not even now generally known how great is the undertaking, and what confidence and courage the engineers and the financial groups had when they tackled this great enterprise. But the tangible results already achieved speak for themselves. At the various sites, such as the Roan Antelope, N'Kana, Mufulira, Kansanshi, &c., there are at least 500 million tons of copper ore proved, and in all probability further research will double, perhaps treble, this huge quantity, of which a great proportion averages nearly 4 per cent. copper, while much goes considerably higher, and an enormous tonnage is about 3 per cent. metal. Going over the N'Kana lay-out, it was impossible for the writer—or, in fact, anyone with a knowledge of machinery—to fail to admire the lay-out and design of the plant. The crusher house impresses one as well-designed and well arranged, and as being very flexible, the latter a very important point not always found in crusher houses. In case of a hold up at any one point, the ore can be switched over to another conveyor belt, so that no delay is caused. The flotation house is roomy, airy, and well built, admitting of easy supervision, and consequently good work. Watching the machines continuously discharging, one could not but marvel at the advances made in mining practice in the past ten or twelve years. The wealth of the copperfields has only become potential owing to the discovery and improvement of flotation methods; water concentration by gravity could not give the excellent results that are being obtained at N'Kana to-day. One of the two huge reverberatories was in full swing, but the workmen were new to the job, and greater ease of manipulation has no doubt by now been achieved. Owing to the nature of the concentrates, not a great deal of slag was being produced, but even so one wondered to what use the large tonnage of waste molten material might be put. No doubt some use will be found for it eventually, and thus another economy will be effected. The converter house, where the product from the reverberatories is "blown up" and finally run into moulds for shipment, is a fascinating place, where one could spend hours watching the big lifting cranes and the pouring of the molten metal. The great smelter stack is a massive and imposing piece of work. In the power-house the plant has been supplied, one was pleased to see, by a well-known British firm, the Metropolitan-Vickers Company. There is no doubt that a good job has been done at N'Kana. Some mistakes have been made, but that is inevitable in any great undertaking. Nothing has occurred to cast any doubt upon the ore reserves and the grade thereof, nor are any unexpected snags apparent. On the contrary, the metallurgical results are good and will be better, with the consequence that costs are coming down, and with sound management and strict economy there is no reason why N'Kana should not presently be in a position to benefit perhaps more than any copper mine in the world when the inevitable reaction from present conditions occurs and the rise in prices takes place.

Kosi Bay.

The possibility of Kosi Bay, Tongaland, as a port to serve the Rand and the hinterland is again attracting attention. General Kemp, Minister of Agriculture, has just paid a visit to the Bay, while inspecting the Pondola irrigation scheme near by. General Kemp's object in visiting the Bay was to see it for himself, so that he may have a better idea of its possibilities as an alternative outlet or inlet. A few years back Union Government engineers examined the Bay and reported favourably upon it as an alternative to Lourenco Marques, if the Union failed to get a Customs agreement with the Mosembique Government.—

Union Mineral Output.

The total value of the mineral output of the Union for the month of May was £4,380,122, an advance of £80,471 over the shorter month of April. There was a record output of gold, the value being £4,103,562. There was an advance in coal and iron ore, and also in copper and tin. In the case of copper the advance was probably due to the Government subsidy. There were decreases in platinum and several minerals with outputs of very little consequence. Diamonds recovered are not included in the total, as the Government only furnishes the particulars half yearly.

Railway Works in Natal.

Work has been restarted on the new 10-mile line between Darnall and Tugela, on the north coast of Natal. The estimated cost is £136,000. The new line will eliminate steep gradients and unnecessary curves, and will greatly improve running. The finishing touches are to be put to the Tugela bridge, which is capable of taking much heavier loads than the old bridge. A start is also, at last, being made on the Bay railway scheme for linking Durban Point with Durban Congella. The complete scheme will cost £178,000. It is reported that the Administration is contemplating transferring the Maritzburg locomotive sheds and stores to Durban. A move of this kind has been expected for several months, as it was recommended by a recent Railway Economic Commission. As there are facilities in Durban for coachbuilding and heavy repairs to engines and rolling stock, exactly as in Maritzburg, it is fairly certain that the Administration will seize the opportunity of centralising its workshops in one town.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Activity Resumed.

ALTHOUGH output from the iron and steel mills and the manufacturing works of the Midlands and Staffordshire is on a somewhat smaller scale than usual for the season, work has now been resumed at all but a few of the establishments and steady progress in the rate of production is looked for. As the autumn season approaches prospects improve, and a very definite accession of business in the near future is anticipated. The month is almost bound to be a quiet one in iron and steel circles, and although there was an improved attendance at the weekly meeting of the Midland iron trade in Birmingham this week there was only a restricted volume of business transacted. The market tone was reasonably cheerful and selling prices in the main were firmly held.

Steel Prices.

Those structural engineers and other users of heavy steel who have been hoping for cheaper material have again been disappointed, for the Steelmasters' Association, after carefully reviewing the position, decided to make no change in existing rates. Among consumers it has been urged for some time that a reduction in the price of sections, joists and plates is overdue. The scale has remained unaltered since the beginning of last year, when the preferential rates to buyers who confined their dealings to British steel were increased. It is understood that there was a preponderance of opinion at the recent conference that producers would reap no countervailing advantages for any better terms they might give now, and that the situation should be reviewed later in the light of the investigation now proceeding. Quotations remain as follows:—Angles, £8 7s. 6d., less 15s.; tees, £9 7s. 6d., less 15s.; joists, £8 15s., less 22s. 6d.; ship, bridge and tank plates, £8 17s. 6d., less 15s. Demand this week has been poor and millowners have had difficulty in arranging rolling programmes. Users only take sufficient material for immediate needs, and there are hardly any holdings of material at the consuming works. The mills have to keep ample stocks, as immediate delivery is a condition of a very large proportion of the business offered. Engineering factories in this area are calling for special steels, and the demand for plates also shows some improvement. Boiler plates are this week quoted £8 7s. 6d. to £8 10s. In the steel semis branch of the market there is no change in the position as existing before the holidays. Continental competition is fierce and native material is undersold. There is no great volume of work going overseas, however, consumptive requirements being small. Re-rollers in this area quote £6 7s. 6d. for small re-rolled bars and £7 for all-British bars. Soft billets range from £4 17s. 6d. to £5 7s. 6d., while sheet bars are £4 15s. upwards.

Manufactured Iron.

Some of the rolling mills are idle again this week, as are a number of the ironfoundries, but in other cases work was resumed, although on a restricted scale, on Monday after a full week's holiday. There was a very small accumulation of orders, business being particularly slack, even for this season of the year. Unfortunately, in this department of Black Country industry there is little likelihood of a substantial development of demand this month. With the approach of the autumn, however, business should show definite signs of revival. In the best bar branch makers are holding fast to their quotation of £12 per ton. For exacting engineering requirements it is claimed that there is no iron just like Staffordshire marked bars, and any reduction of selling price in the present state of demand would be uneconomic if the standard is to be maintained. In the Crown bar department makers are faced with considerable competition from other districts, which offer material at lower prices than local producers can entertain. It is held that Staffordshire Crown iron is superior to that made in other areas, and it is significant that a certain number of orders come to district makers despite their higher selling rate. While bars are to be had on this market at slightly below £9 per ton, orders are occasionally placed with Staffordshire makers at nearly £10 per ton. There are few, if any, local producers of Crown iron who would accept the lowest price named on the market this week. In the common bar branch, which manufactures bars for the bolt and nut and fencing trades of the Black Country, business is almost stagnant. Competition from France and Belgium is very severe again, and material is offered at prices practically the same as those quoted before the protective tariffs were imposed. Ironmasters in this department are no better off than they were before the change in the country's fiscal policy. The gap between home and foreign prices was so large that really little hope was entertained of successful competition in this branch when the tariff was imposed. It is slightly narrower now, but the alteration bears no relation to the alteration which one would expect to be brought about by the devaluation of the pound and the imposition of a 33⅓ per cent. tariff. Staffordshire makers' quotation of £7 15s. for fencing bars and £8 for nut and bolt bars, although very low, brings hardly any business. Wrought iron tube strip is slightly easier in price, a fall of half-a-crown per ton in the minimum selling rate having taken place. Quotations range from £10 7s. 6d. to £10 10s. per ton delivered. It is reported that there has been some small increase in demand this week which may be due to restocking at the lower rate now prevailing.

Pig Iron.

The position at the blast-furnaces in the Midlands has not improved as a result of the holidays. Stocks have increased and furnacemen are anxious to find an outlet even for their current output. Some of the foundries have only just resumed operations and consumptive requirements this week have been light. An increased call for material from the light castings trade is eagerly anticipated. Selling prices are as fixed by the Central Pig Iron Producers' Association, namely, Derbyshire No. 3 foundry, £3 6s.; forge, £3 1s.; Northamptonshire No. 3 foundry, £3 2s. 6d.; forge, £2 17s. 6d., all per ton delivered Black Country stations and subject to rebate in the case of large users.

Galvanised Sheets.

Rolling was generally uniform this week in the galvanised sheet mills of the district. In some cases a resumption was made in the middle of last week, but it was only where mills were favourably placed by having sufficient orders on their books to keep them occupied for some time. Financial constriction abroad is having an adverse effect upon sheet business. There is an undoubted demand, but it is held up by financial factors. Under these circumstances there is unusually keen competition for the orders which become available, and overseas buyers are using the occasion to force prices lower. Acceptance of £9 per ton for galvanised corrugated sheets of 24 gauge in special cases has been followed by offers of £8 17s. 6d. It does not appear that these offers have been entertained, however. Quotations range from £9 2s. 6d. upwards. Home demand is about maintained and there is no notable change in values of material for this market. Black sheets are in moderately good request.

Ironworkers' Wages.

Under the sliding scale of the Midland Iron and Steel Wages Board the rate of pay for puddling was this

week reduced by 2½ per cent., and other forge and mill wages underwent a corresponding reduction. This results from the bi-monthly ascertainment for May and June, which showed a further decline in the selling prices of the products which enter into the calculation. The average net price was £9 10s. 9d. on an output of 15,448 tons by the selected firms. Wages are now 22½ per cent. over the basis rate of 13s. 6d. per ton for puddling.

New Switchgear.

The Wolverhampton Corporation Electricity Committee proposes to expend over £77,000 on new switchgear, required to meet the new conditions which will arise on connection being made with the "grid" system. An expenditure of £60,975 is required on the headquarters switchboard, and £16,553 on switchgear reconstruction at sub-stations. The main contract of £43,813 has been given to the General Electric Company, Ltd., of Birmingham, for the supply of a thirty-seven panel, 500,000 kVA rupturing capacity 6000-volt switchboard, complete with control board.

Unemployment.

The Midlands area shows up well in the statistics of employment this week issued by the Ministry of Labour. The increase in the total number of employed on the register on July 25th in the Midlands area was 1070, and was the smallest increase of all the administrative divisions. The totals for the Midlands were 245,031 wholly unemployed, 152,959 temporarily stopped, and 586 normally in casual employment, an aggregate of 398,576. This was 8287 fewer than a year before. The total comprised 316,243 men, 9840 boys, 66,194 women, and 6299 girls.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Problems of Redundant Plant.

AN end to the serious problems arising out of the Lancashire cotton industry's surplus productive capacity is not yet in sight. First and foremost, of course, is the repercussion on the cotton trade itself, although the effects are much more widespread. The fact that the last ten years has provided little or no work for constructional engineers in connection with domestic cotton mills is only one of the adverse effects. Another important branch of Lancashire engineering to suffer severely as a result is that concerned with the manufacture of textile machinery. Recent years have witnessed a progressive diminution of the purchasing power of the home market for textile machinery, and this problem of redundant plant in no small degree has had its reactions on many of the export outlets for Lancashire machinery of this class. It is no secret that much surplus cotton mill machinery has been bought at prices which in many instances have represented little more than its scrap value, reconditioned, and disposed of to overseas markets. Textile machinery makers have been powerless to put an end to this business, and have had to suffer in consequence. The matter was raised some time ago in the House of Commons, but it is difficult to see how, without undue discrimination, the export of second-hand textile machinery could be prohibited.

The Flow of Scrap.

Other sufferers from the same cause, both in Lancashire and Yorkshire, but especially Lancashire, have been Midland pig iron makers. During the last few years textile machinery has come on to the market in the form of scrap in ever-increasing quantities, and the flow shows no sign of abating. In more normal times, the price advantage enjoyed by good quality machinery scrap over pig iron was no greater than half a crown or 5s. a ton. Now it is more of the order of 30s. to 35s. a ton. The result has been the entry of scrap as a raw material of the foundry on a bigger scale than ever relative to new iron, and it is this factor almost as much as actual trade depression which is limiting the sale of pig iron in the Lancashire district. When the end of this abnormal flow of scrap will be reached is problematical, but it is certain that it is still some distance off. The cotton trade itself has not yet agreed upon a scheme for the scrapping of its surplus plant, and when it does, as it must inevitably sooner or later, the supply of scrap is likely to increase before it shows any sign of material reduction.

Non-ferrous Metals.

Following upon the advance recorded a week ago, there has been a further substantial rise in all sections of the non-ferrous metals market during the past week. Primarily, the improved tone has been largely sentimental in character, based upon brighter stock market conditions here and in the United States, although the movement of the sterling-dollar exchange has also been a factor, with a slight expansion of buying interest from consumers in certain sections. So far as the actual statistical position of copper is concerned, there has been no change for the better, although there is a less ready disposition on the part of producing interests to enter into forward commitments as far ahead as they have been disposed to do in the past. The rise in standard brands of copper has been in the region of £2 10s. per ton, and follows on one of similar magnitude in the previous week. At about £7 per ton, the advance in the case of tin has not been quite so steep as the one recorded a week ago, although it is a formidable one and has brought values back to where they were at the end of January. Lead is dearer on balance by 10s. per ton and spelter by between 15s. and 17s. 6d. In all of the metals the turnover has been much above the recent average, although probably the major portion of it has been speculative in character. How far the improvement in prices will be sustained is doubtful, but, apart from the natural reaction which may be expected to develop on profit-taking, there is a feeling in certain market quarters that a further upward movement may be witnessed.

Iron and Steel.

Seasonal factors are largely responsible for the continued quiet conditions on the iron and steel markets here, although the general opinion this week has been that the slackness has been rather more pronounced than it usually is, even at this time of the year. Deliveries of foundry pig iron into consumption have shown a declining tendency, and there has been no awakening of interest so far in respect of forward contract buying. Even the light castings branch, which has been relatively the most favourably placed during the past six or nine months, is less satisfactorily situated than it was. Quotations are maintained on the basis of 67s. per ton for Staffordshire, Derbyshire, and North-East Coast brands of No. 3, 65s. 6d. for Northants, 62s. for Derbyshire forge iron, round 85s. for Scottish No. 3, and 81s. for West Coast hematite, including delivery in each case to works in the Manchester district. Buying of manufactured iron is on a retail scale, with Lancashire best quality bars quoted at £10 5s. per ton and Crown bars at £9 15s. The movement of steel into consumption, both in the heavy branches and in alloy steels, is almost wholly on hand-to-mouth lines, without any material change with regard to prices. Acid and basic quality boiler plates are obtainable in the region of £8 10s. per ton, with small re-rolled bars at £6 15s. to £7, joists at £8 15s., sections at £8 7s. 6d., tank plates at £8 17s. 6d., and large diameter bars at £9 7s. 6d. Foreign products on the Lancashire markets are attracting little attention, and whilst values have been advanced slightly in consequence of exchange fluctuations, the undertone is decidedly weak, and the prices that are being indicated are nominal and would be shaded to the extent of several shillings a ton if business were available.

BARROW-IN-FURNESS.

Hematite.

There is nothing fresh to report about the hematite pig iron market, which remains quiet. The output is still down, owing to the Barrow furnaces being idle during overhaul. The furnace at Backbarrow, which is devoted to the production of special iron, is also undergoing its periodical overhaul. With the steel works at Barrow temporarily idle, there is little local demand for iron. There still remain plenty of stocks in the district to supply more than present demands for some time. American and Continental business is practically at a standstill at present. The home demand is small but steady, and is confined to buyers' immediate needs. The iron ore trade is very quiet, owing to a reduction in the number of active furnaces in the district, and the outside demand is thin. Foreign ore is similarly situated. The steel trade remains quiet. The Barrow rail mills have not started again, but the hoop and small section units resumed operations this week.

Shipbuilding.

The 22,000-ton liner "Bermuda Queen," will probably be launched from Vickers yard at Barrow about September 1st, according to present arrangements. She will differ somewhat from the "Monarch of Bermuda," although it was at first intended that she should be identical. Experience with the "Monarch" on service suggested certain alterations, and these have been incorporated in the "Queen."

SHEFFIELD.

(From our own Correspondent.)

No Revival in Sight Yet.

RESUMPTION of work after the Bank Holiday stoppage was not general until the beginning of this week, and the position, when it did become normal, showed no improvement upon that which existed before the suspension. The buying movement which is so much desired has not yet developed, and, although steel production is being carried on on the scale recently reported, there is the same scarcity of bulk orders and inquiries. With regard to shipbuilding steel, some encouragement is to be found in a report from London that contracts have been placed on the Clyde for three new vessels, and that important Admiralty orders are expected in the near future, but the demands of the shipyards upon local steel makers at present show no increase. On the railway steel side it is interesting to know that the United Steel Companies have secured a contract from the South African Railways and Harbours Board for 100,000 steel sleepers, weighing approximately 6000 tons. Such sleepers, however, are not made in Sheffield, and the order has gone to the Workington branch of the company. It is announced that the Chinese Government has placed orders for 10,000 tons of steel rails with several British firms, but there is no news at present of the ordering of any Sheffield steel specialities for that country, and the local shops making axles, tires, and springs remain short of work.

Special Manufactures.

A revival of general trade is not to be expected at present, as this is always a quiet season of the year, but there are distinct signs of increased business in several important lines in September. Some of the lighter branches of manufacture continue to enjoy considerable activity. Among them is the trade in motor car parts and special steel, which keeps up very well, and provides a large volume of employment for several firms. Stainless steel and its kindred materials, already in use for a large variety of purposes, are still being developed to meet new needs, and a good demand is experienced. Steel strip, both hot and cold rolled, maintains the improved position which it has secured this year, and there is a good call for best wire. The state of the tool trades is uneven. Twist drills, hacksaws, and some other branches are well employed, but there is much slackness in the saw and file departments.

Stainless Steel at Sea.

The extent to which the uses of stainless steel have been developed are incidentally illustrated by a very interesting test, which has just been begun, concerning the employment of the material at sea. It is the most complete test of its kind that has ever been undertaken. It has been arranged by Mr. S. Bernard Attenborough, who for some time has been a director of Stainless Steel Goods, Ltd., a company which has as one of its main objects the development of the use of stainless steel for purposes other than cutlery. The test has been approved by one of the leading steel companies specialising in stainless steel, and by the marine superintendent of an important shipping company. It is being carried out on a ship which is now on a voyage to Australia, and which, on its journeys to and from the Antipodes, will encounter every kind of weather condition, including passing through the monsoon. No fewer than seventy samples, all of stainless steel produced in Sheffield, are being tested. They include steel plates, riveted steel sheets, tubing drawn and welded, bolts and nuts, wire, wire netting, castings, water taps, sanitary fittings, door fittings, coat fittings, butchers' fittings, spoons and forks, all-stainless steel knives, and teapots.

Efficiency and Economy.

There is little doubt that the steel will stand all the tests of the sea and weather. This has already been partially proved by previous experiments. But the test now being carried out is more complete, and, moreover, the question of economy, which is as important as the use of the metal itself, is also being fully considered. Ships at sea, many of which are motor-driven, are not likely nowadays to collect impurity from the air, but when in port, in proximity to large industrial cities, their fittings can be contaminated by such impurities in the same way as those of any of the buildings in the city itself. This side of the question is being fully taken into consideration in the present experiments, as well as the questions of the economies to be effected by the saving of labour and cleaning materials, losses due to the corrosion of ordinary ship plates, both to the plates themselves and other parts of the ship adjacent to them, saving of paint and repairs, the saving of damage from barnacles and other marine growths, due to the greater smoothness of stainless steel, and many other matters.

A Great Water Project.

The City Council of Hull has resolved by a majority of forty-four votes to five to take steps to secure its future water supplies by applying for parliamentary sanction for one of the greatest schemes of waterworks extension that has been brought forward in this part of the country for a long time. The proposal is to acquire land in Farndale Valley, North Yorkshire, about 50 miles from Hull, and there to construct a reservoir which will have a capacity of 6000 million gallons. This reservoir will, it is stated, be the second largest in the country. The scheme is estimated to cost from 1¼ to 1¾ millions. The reservoir will be 2 miles long, ¼ mile in greatest width, and at its southern extremity the depth will be 110ft. It will give a supply estimated at 16,673,000 gallons per day, to be added to the present Hull supply of about 13,000,000 gallons daily. At present the city derives its supply from pumping works, but the proposed new supply will be by gravitation, and the water will be conveyed by pipe to the existing waterworks at Keldgate. Some time ago the Corporation adopted a scheme for new pumping works at Kelleythorpe, at an estimated cost of £885,911, but the approval of the present scheme is accompanied by a decision to abandon the Kelleythorpe project. The Farndale scheme is not essential for present requirements, as Hull is not short of water, but it is a measure of provision for the future, and is calculated to ensure an adequate supply to the city for a hundred years. A point in favour of the Farndale water is its softness. It is calculated that, comparing this water with the present hard water obtained from deep wells, there will be a saving in soap and other cleansing materials, on 75,000 houses, reckoning four persons to a house, of £182,000 per annum, or £2 8s. 6d. per house. It may be three years before a start can be made with the scheme, and six years from the start before the water is available in Hull.

Wombwell Colliery Progress.

Steps to acquire new mineral rights are being taken by the Wombwell Main Colliery Company, which is proposing to work an area underlying the centre of the town. The company has given formal notice of an application for sanction to work the Fenton, Parkgate, and other seams (not including the Barnsley), which lie below a depth of 300ft., covering an area of 39 acres. It is also applying for ancillary rights, including powers of underground wayleave, drainage, and ventilation. The application is to be heard on November 21st. Another mining extension project in the same district is the commencement of sinking operations at Hemingfield, with a view to working the Abdey (or Winter Bed) seam of coal. This scheme is being carried forward by Mr. William Gedney, who has previously been identified with enterprises of this kind, and with whom others are associated. The Abdey seam is some 2ft. 6in. thick, and yields good quality house coal. It crops out in the district, and it is hoped to strike it at a depth of 27 yards. It is not likely that the mine will employ a great number of men, but the developments are being watched with interest.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE prevailing quietness in the Cleveland pig iron trade has been accentuated by holiday influences, and there can be no disguising the fact that the present position is discouraging. Not for many years has production been so reduced, and so little plant in operation, yet the disposal of the limited output is an ever-present problem. As producers are rapidly completing the

moderate amount of work which they have on hand, continued scarcity of orders is causing anxiety. Makers would doubtless reduce quotations if they saw reason to believe that such action would induce buying of any moment. Customers are more disinclined than ever to discuss forward business, and trading is almost confined to transactions in small parcels to meet early requirements. Local consumption of pig iron will be much reduced during the next fortnight by the closing of foundries and steel works for the usual August holiday. Demand from other districts is light, and the export trade is negligible. Stocks are increasing, notwithstanding the closing down of more blast-furnaces. Prices are unchanged, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

The demand for East Coast hematite pig iron has fallen off to a considerable extent as a result of seasonal influences, and the fact that some of the consuming works are not taking deliveries owing to the holidays. Hematite is comparatively cheap. Prices are not definitely fixed and buyers state that they can cover needs at well below the rates asked. Merchants are keen to unload their holdings and are underselling makers. The latter base quotations on ordinary East Coast qualities at 61s.

Ironmaking Materials.

There is so little business passing in foreign ore that values are difficult to fix. The nominal price of best Rubio is 14s. 9d. c.i.f. Tees. Prompt small parcels can, no doubt, be picked up at that figure, and possibly rather less, but merchants would not enter into contracts for supply over a period on such terms. Local users of blast-furnace coke are well placed as regards supplies. They still have considerable quantities of their own makes to draw upon and are not obliged to buy. There are sellers at the equivalent of good average qualities at 15s. delivered to works in this area.

Manufactured Iron and Steel.

Little improvement can be reported in the various branches of the manufactured iron and steel trade. Foreign competition continues keen and purchases can still be made from firms abroad at lower prices than are asked for home products, notwithstanding tariffs and other obstacles with which Continental firms have to contend. An order for 2000 tons of Continental sheet bars is stated to have been placed. Manufacturers of constructional steel have a fair amount of work to execute, but producers of nearly all other commodities are greatly in need of orders. Quotations are unchanged.

Order for Three Bridges.

Dorman, Long and Co., Ltd., Middlesbrough, have been awarded contracts by the L.M.S. Railway for the construction of three bridges—two on the Macclesfield to Colwich line, and one at Edgware-road, on the Acton branch. These bridges are comparatively small, and will be manufactured at Middlesbrough.

The Coal Trade.

There is some increased demand for Northern coal, mainly for the prime steam grades, and all round the prospects for this month tend towards a brighter movement. Merchants report receiving numerous inquiries, and are offering freely at c.i.f. prices based on current minimum values. They hope to secure a number of orders, but, of course, have to face severe competition from Continental producers. Competition is particularly keen for any business offered in the Mediterranean or Northern Europe. German and Polish sellers are active and Russian suppliers are doing all they can to get trade in the Mediterranean. No extra demand has yet been experienced in this district as a result of the report of the spread of the miners' strike in Belgium. On the contrary, it is believed that if all the pits cease work it will lay other industries idle, and no fuel will be required for the present. It is a tradition that miners' strikes on the Continent are short-lived. Northern producers, however, await with interest the course of the present dispute. Recently, there were indications of Belgium making a further cut in coal imports in order to enforce a greater use of national fuel and to reduce stocks, which are said to be fairly heavy. Prime Wear steams are all booked for prompt, and have improved prospects for the remainder of the month. Prime large are quoted steadily at 15s. to 15s. 1½d., and small sells freely at 11s. Northumberland steam coal, while steady in tone, is offered freely, and buyers could, doubtless, cover any quantity for any part of this month at 13s. 6d. This grade of small is steady at 8s. 6d. Tyne prime large coals are moving slowly at 12s. 9d., but small are in demand at 9s. There is a moderate inquiry for bunker coal for prompt shipment at 13s. 6d. for favourite and 13s. for ordinary qualities, and forward the tone is just quietly steady at similar values. Durham gas coal is, on the whole, quiet, but prompt shipments are more active, and for forward a few Italian inquiries are circulating. Merchants hope to secure these on the basis of current quotations. Best gas coal is offered at 14s. 6d., and secondary at 13s. to 13s. 6d. Prime Wear gas is steady at 15s. to 15s. 1½d. Durham coking unscreened and small are easy and nominal at 12s. 6d. to 13s. 9d. Recent sales of gas coke both for prompt shipment and over the winter months have given a good tone to the market, but buyers can still obtain supplies for prompt shipment at 17s. to 17s. 3d. For later deliveries, however, 17s. 6d. for best is firmly indicated. Patent oven coke is moving very slowly, and with ample stocks prices remain easy at 14s., and for superior qualities 15s. to 16s.

Rail Order from Canada.

An order for 600 tons of electrical steel rails for Montreal has been placed with Dorman, Long and Co., Ltd., Middlesbrough. This is the first rail order received from the Dominion by the firm for many years past, and is the result, no doubt, of the agreement which was arranged by the two countries before the Ottawa Conference.

SCOTLAND.

(From our own Correspondent.)

Steel.

The steel market is not yet rid of the holiday influence. Although most of the works are again in operation, the general inquiry is still on restricted lines. There have been indications, however, that overseas business might reasonably be expected to show a tendency to increase during the autumn months, more particularly perhaps in sheets, and to a lesser degree in tubes. Fairly good shipments of steel are going to Canada and South America, and there are prospects of more business in sheets with China. The position regarding heavy steel is still rather obscure, depending as it does to a large extent on the conditions obtaining on the Clyde; but should the work in prospect for the shipyards materialise, an improvement in the demand for heavy material will probably follow. Business in plates, sections, and sheets with the Irish Free State shows a decline already.

Iron.

Conditions in the iron trade are similar to those ruling before the holidays. Buyers are still content to purchase in small quantities against actual requirements, and show no disposition whatever to anticipate supplies. The accumulation of orders during the holidays was comparatively light. Bar iron at £9 15s. home and £9 5s. per ton export is not an attractive proposition in competition with foreign material or home steel, and makers continue to experience great difficulty in securing even a minimum proportion of the orders in the market. The same may be said of re-rolled steel bars, which are quoted £6 10s. home (fixed) and £6 7s. 6d. per ton export.

Pig Iron.

The number of furnaces in operation in Scotland has been reduced to one by the damping down of the two furnaces at Clyde Works, which have been making hematite. Only small lots are changing hands in the meantime, and stocks are ample to meet all calls. Prices are unchanged.

Scrap.

Scrap material is still easy, with cast iron machinery quoted at 45s. and heavy steel at 35s. per ton.

Coal.

Shipments of Ayrshire and Lanarkshire coal to the Irish Free State have been maintained, but business in this direction is now much quieter, and it would cause no great surprise if the tariff was increased sufficiently to exclude this traffic altogether. Business with foreign buyers is still extremely difficult, and cargoes are mainly of small proportions and for immediate dispatch. Practically all descriptions of round coal are short of orders. Best Fife steams are comparatively firm, owing to reduced outputs, but Lothians steams and Lanarkshire splints, ells, and steams are easily obtainable at prices subject to adjustment. Treble and double nuts, especially the former, provide the firm spots in the market. Singles are steady, but smaller sizes are weakening. Aggregate shipments amounted to 209,954 tons, against 232,123 tons in the preceding week and 169,948 tons in the same week last year. On the average the pits in Scotland are working about three days per week.

The Late Mr. C. J. Hunt.

Electrical engineers in Scotland will regret to learn of the death of Mr. C. J. Hunt, the assistant general manager of Bruce Peebles and Co., Ltd., of Edinburgh, which took place in a nursing home in Edinburgh last week following an operation a few weeks ago. Mr. Hunt had a wide circle of friends, both in Edinburgh and London, and his death will be widely regretted, both in this country and abroad. He received his early electrical training as a pupil of Johnson and Phillips, Ltd., and in 1906 he joined Bruce Peebles and Co., Ltd., with whom he has been associated from that time, and has been engaged in carrying out important electrical contracts in various parts of the country.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coalowners and Co-operation.

The reference in my letter last week to the possibility of the establishment of a consortium for the distribution of coal in Italy, the effect of which would be the centralised buying of coal, is of more than ordinary interest in view of the developments pending on this side and the fact that news has leaked out relative to a scheme on the part of the leading undertakings producing steam and anthracite coals to co-operate in order to prevent underselling and to push the marketing of coal in order to compete with oil and other sources of power. Incidentally, there will be co-ordination in coal production so that coals required will be produced at the most economic pits, thus further enabling Wales to compete. The details of the scheme are, so far, withheld; in fact, nothing official regarding the matter is forthcoming, but, on the other hand, sufficient has been made known to enable it to be said that the scheme is complete. When it is to come into operation is not disclosed, although the belief is entertained that it will take place at the end of the year. Rumours, of course, have been current for some time that there were likely to be developments and centralised selling has been strongly advocated in some quarters. So far as anthracite coals are concerned, inasmuch as production of 75 per cent. or more of this coal is in the hands of one firm, little scope remains for further development; but with steam and bituminous coals in Glamorgan and Monmouthshire, it cannot be denied that room existed for closer co-operation, although it has to be admitted that the bulk of production even of the latter is under the control of about six undertakings. The report is that these leading undertakings responsible for over 75 per cent. of the production of steam and bituminous coals in this area are becoming members of the new association which is in process of formation. It is stated that it is incorrect to say that as the result of this new organisation centralised selling is to come into operation; but it is difficult to shake off the feeling that this new scheme is a definite step towards it. As things are, however, there is apparently some authority for saying that under the scheme the members will retain their freedom, but unquestionably there will be more co-operation among them for the purpose of preventing underselling, and organisation of effort to improve the position of Welsh coals in the markets of the world. Naturally, the market has been very much alive with reports as to what the scheme may mean for those who are interested in the coal export trade of this district, but who have no producing interest. All the leading colliery combines have their export departments, and all developments of recent years have been, without doubt, inimical to the interests of the middlemen. It will be interesting to see what the effect of this new scheme will be in this respect. It may be added that the new association is to operate quite independently of any existing body in this area.

The Coal Trade.

As was to be expected, shipments from the leading ports in South Wales last week were much reduced on account of the holidays. According to the returns of the Great Western Railway, the total for the six docks under its control only came to 244,765 tons, which compared with 394,745 tons for the preceding week and with 259,112 tons for the corresponding week of last year. At the end of last week there were as many as forty-seven vacant loading berths at the various docks. Even at Swansea conditions were not as active as had been experienced for some months previously, as three vacant loading berths were reported. Since the holidays the position at Swansea has again improved, as on Tuesday last there was only one idle berth, while four steamers were waiting; but at the ports where steam coals are mainly shipped the number of idle tips was thirty-two. Undoubtedly, steam coals are quiet, and the foreign demand remains comparatively slow. The strike of miners in the Belgian coalfield has not had the effect of bringing more business to South Wales, while shipments from this district to the Irish Free State last week, according to the Customs returns, were only 2170 tons, which compares with over 13,000 tons during the preceding week. Inquiries show that under the pressure which is being put upon consumers in the Free State, the demand for coals from South Wales is gradually diminishing to negligible proportions. As regards France, the news is to hand that the French import quota for the current month is to remain at 70 per cent. of the monthly average quantities for the three years 1928–30, but with this difference, that licences have been granted to importers on the basis of 54 per cent., which leaves 16 per cent. in the discretion of the Direction of Mines, whereas, formerly, this percentage was 10 per cent. Operations on contract account, like business for prompt loading, are extremely quiet, but the Casablanca Electric Works are in the market for 13,000 tons of sized coals for delivery in three cargoes at the end of August, September and October. In the face of the existing conditions it is refreshing to hear some one strike an optimistic note. Mr. W. Lindsay Carlow, who is the chairman of the British Coal Exporters' Federation, was in Cardiff this week and made the statement that "although the coal export trade of the United Kingdom is still considerably less than that required to put collieries in a comfortable position, there are some encouraging features to be found in a study of world conditions, for we have definitely improved our position as compared with foreign-producing countries during the last six months."

Docks Facilities.

With reference to the movement on the part of the Great Western Railway for effecting economies at the South Wales docks, there was a private meeting on Sunday last of the three Penarth branches of the National Union of Railwaymen to consider the question of voluntary reduction of wages which had been suggested by the general manager of the railway company. No official statement was forthcoming at the close of the proceedings, but it is understood that the men declined to entertain the proposal, the majority being of the opinion that the financial position of the workmen was such that no offer could be made.

Current Business.

Anthracite coals continue firm and scarce, but steam coals vary considerably. Owing to the slow demand for large steam coals it follows that the production of sized qualities is restricted. As a consequence, supplies of the latter are difficult to obtain for prompt loading and maintain a good tone, but most descriptions of large and smalls are in excess of market requirements and remain at the minima. Coke meets with a very moderate inquiry, but patent fuel is well stemmed. Pitwood is very steady at 22s. to 23s.

CONTRACTS.

Crossley Motors, Ltd., of Manchester, has received a third repeat order from Hong Kong for the conversion of a further three petrol-driven omnibuses to oil drive. This order makes a total of eight omnibuses converted from petrol to Crossley oil drive.

The D.P. Battery Company, Ltd., has received an order for three 300-volt "Kathanode" submarine batteries for a foreign navy. The batteries will have a combined capacity exceeding 26,000 ampère-hours. This order follows two previous orders for "Kathanode" batteries for the same navy.

Ruston and Hornsby, Ltd., Lincoln, have received from the Godalming (Surrey) Corporation a contract for waterworks pumping plant to be installed at the Borough-road pumping station. The main unit comprises a three-cylinder Ruston vertical oil engine, driving three centrifugal pumps. A feature of interest is the arrangement whereby six alternative pumping duties are possible to suit particular local conditions. Auxiliary pumping and electric plants are included. The pumps will be manufactured by Mather and Platt, Ltd.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/6 to 20/-
(1) Spanish	17/- to 22/6
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	14/9

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 1 0	3 1 0
No. 1	3 1 6	3 1 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a) / 4 0 6 (b) / 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
Lancs.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 10 0	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 0 0	10 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0 to 7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0 to 8 12 6	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets, f.o.b. L'pool	9 2 6 to 9 7 6	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/0 to 15/6
Block Tin (cash)	140 0 0
„ (three months)	141 10 0
Copper (cash)	30 2 6
„ (three months)	30 2 6
Spanish Lead (cash)	10 15 0
„ „ (three months)	11 5 0
Spelter (cash)	13 3 9
„ (three months)	13 10 0
Manchester—	
Copper, Best Selected Ingots	35 0 0
„ Electrolytic	36 0 0
„ Strong Sheets	62 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9
„ Condenser, lb.	0 0 11½
Lead, English	12 17 6
„ Foreign	11 10 0
Spelter	13 7 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 0 0	8/-
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 15 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	11/-
„ „ „ 1 p.c. carbon	£47 0 0	14/-
„ „ „ 0·70 p.c. carbon	£48 0 0	16/-
„ „ „ carbon free	1/1 per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 6/- per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	8/- per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/-
„ „ Ell	14/-
„ „ Splint	13/9 to 14/9
„ „ Trebles	13/-
„ „ Doubles	11/6
„ „ Singles	10/-
Ayrshire—	
(f.o.b. Ports)—Steam	11/6
„ „ Jewel	16/6
„ „ Trebles	13/- to 13/3
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 12/6
Screened Navigation	16/6
Trebles	14/6 to 15/6
Doubles	12/-
Singles	9/9
Lothians—	
(f.o.b. Leith)—Best Steam	11/- to 11/6
Secondary Steam	10/6
Trebles	14/-
Doubles	11/6
Singles	9/6

(8) N.W. Coast— ENGLAND.

Steams	21/9
Household	32/6 to 51/6
Coke	19/- to 22/6
Northumberland—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/-
Household	27/- to 39/-
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	24/-

Sheffield—	Inland.	
Best Hand-picked Branch	25/- to 26/-	—
South Yorkshire Best	20/- to 21/-	—
Derbyshire Best House	20/- to 21/-	—
Derbyshire Best Brights	17,- to 18/-	—
Screened House Coal	15/- to 16/-	—
Kitchen Coal	14/- to 15/6	—
Best Screened Nuts	15/- to 16/-	—
Small Screened Nuts	13/6 to 15/6	—
Yorkshire Hards	16/- to 18/-	—
Derbyshire Hards	16/- to 18/-	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/- to 8/6	—
Blast-furnace Coke (Inland)	9/6 to 9/9 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 13/6 to 15/6		

Cardiff— (9) SOUTH WALES.

Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/- to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 13/-
Washed Nuts	19/- to 25/-
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/- to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/- to 18/-
Patent Fuel	20/-
Pitwood (ex ship)	22/6 to 23/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	36/- to 38/6
Seconds	27/- to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/- to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/-
Breaker Duff	8/6 to 9/6
Rubbly Culm	11/- to 11/9
Steam Coals:	
Large	20/- to 20/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate: Joists (minimum), 22/6: Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Compagnie Generale Transatlantique.

AFTER hearing the report presented by Monsieur Dautry, vice-president, the shareholders in the Compagnie Générale Transatlantique voted unanimously last week against its liquidation, and expressed their confidence in the ability of the new board of directors to reorganise the company and place it eventually on a satisfactory basis. It will be remembered that the old board had to resign before the State would come to the relief of the company, and the new board is representative of shipping and maritime interests, as well as of the State, which is controlling the company until such time as its affairs are put in order again. Monsieur Dautry is Managing Director of the State Railways. The balance sheet for 1931 showed a loss of more than 399 million francs, and Monsieur Dautry explained the measures being undertaken to improve the situation of the company by carrying out rigid economies. One of the things that had to be decided upon was whether work should be resumed on the liner at the Penhoët shipyard. The construction of that ship was imposed on the company by the State, and it was decided that, despite the abnormal situation of shipping, it was desirable to continue work upon it for the reason that in three or four years' time most of the liners running between Europe and New York will, it is said, be out of date, and some of them probably withdrawn. If, in the meantime, the passenger traffic should become normal again, the new ship will, it is argued, attract a big share of the business. The liner will have a length of 313 m. and a width of 36 m., and its displacement with fuel and stores will be 67,500 tons. It will steam at more than 28 knots. It will carry more than 2000 passengers in three classes. The ship will probably be launched in October, and will be put into service in 1934.

Shipbuilding.

Representatives of the shipbuilding industry have interviewed the Minister of Marine in the hope of inducing him to do something for the shipyards, the situation of which has become desperate. The director of the Chantier Navals Français—Monsieur Guibaud—has issued a statement declaring that unless fiscal charges and the cost of living are reduced, and the Government and the shipping companies abandon their policy of economising on new construction, the outlook for the shipyards will soon become "tragic." Since May of last year, the only ships ordered have been a 15,000-ton liner for the Messageries Maritimes, a 6200-ton ship for the Compagnie de Navigation Mixte, and four cargo boats. This is all the new work provided for twelve large shipyards, which have seen other orders sent abroad because the cost of construction in France is too high. Every time the State has come to the assistance of shipbuilders it has been too late on account of the steadily widening margin between costs in France and those in Great Britain, and builders find it hopeless to expect to catch up this difference unless the State is able to provide them with compensation.

A Steamboat Inventor.

The generally accepted belief that Fulton was the inventor of the steamboat is being discredited by claims made on behalf of the Marquis Claude-Dorothée de Jouffroy d'Abbans, who died just a hundred years ago. This centenary is being taken advantage of to show in what manner the marquis may be regarded as the real inventor. There was considerable sensation when he demonstrated his "pyroscaphe" on the Saône at Lyons in 1783, and repeated references have been made to it down to recent times. In 1776 the Marquis de Jouffroy d'Abbans is said to have run a boat on the river Doubs with the aid of a "Watt's fire engine actuating oars," but in the steamboat demonstrated at Lyons the same engine drove paddle wheels with such good effect that the local authorities testified officially to the success of the experiment. It is affirmed that the marquis had been in relation with an influential industrialist—Monsieur Perier—who had introduced the Watt engine into France and had installed a pumping plant in Paris near the Pont de l'Alma, where it was still standing in the late 'eighties of last century. Perier, who was a member of the Académie des Sciences, had himself endeavoured to do something with the steamboat, and when the marquis applied for a patent Perier is reported to have used his influence to induce the Academy to oppose it unless the inventor could bring his "pyroscaphe" to Paris and run it on the Seine. This the marquis was unable to do, for he had spent all his fortune on the construction of the boats and on his experiments with them. Moreover, the Revolution obliged the Royalist inventor to emigrate, and for many years nothing more was heard of him. Meanwhile, Perier found an associate in the American Fulton, who had come to Paris with the idea of developing his inventions, and Perier constructed for Fulton the steamboat which ran on the Seine on August 9th, 1803. The French infer that Perier made use of the plans of de Jouffroy d'Abbans, for when the marquis returned to France he claimed an indemnity.

Continuous Brakes.

When the railway companies were required to equip their goods trains with continuous brakes, one-half of the material, to the value of 130 million marks, was to have been supplied by Germany on account of reparations, and the companies were allowed to extend their payments to the French Government over a period of thirty years. The German firms were naturally paid by the German Government, which several months ago decided that reparation payments had gone far enough, and the manufacturers of continuous brakes, after supplying the greater part of the material required, found that they had no alternative but to ask the French companies for payment of the brakes remaining to be delivered. The situation now is that the Government will have to finance the completion of the programme, which it is hardly in a position to do when stringent economies have to be carried out in order to balance the national Budget.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

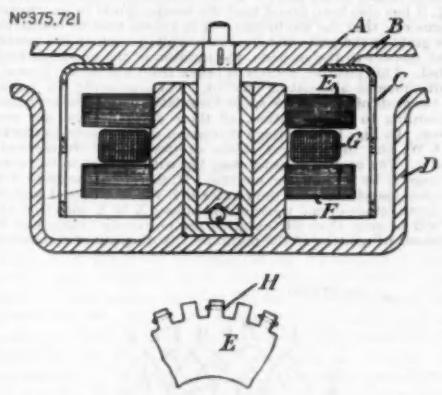
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

375,721. January 16th, 1932.—ELECTRIC MOTORS, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, U.S.A.*

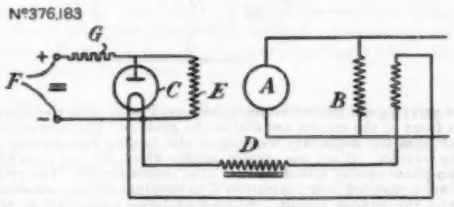
As usually constructed, small A.C. motors of the homopolar type are not self-starting, and the object of this invention is to overcome this drawback by providing each alternate pole of the stator with a short-circuited winding which generates a flux in



that pole having a time lag. The illustration shows the invention applied to a gramophone motor and A is the turntable, which is secured to a hood-shaped rotor B with slots C. The stator D has two laminated tooth rims E F with an A.C. coil G between them. A short-circuited winding H is arranged on each second tooth of each of the two rims, so that each of the short-circuited windings on the rims E and F coincide.—*June 30th*, 1932.

376,183. January 6th, 1932.—AUTOMATIC CONTROL OF THE VOLTAGE OF ALTERNATORS, N. V. Philips' Gloeilampenfabrieken, of Emmasingel 13D, Eindhoven, the Netherlands.

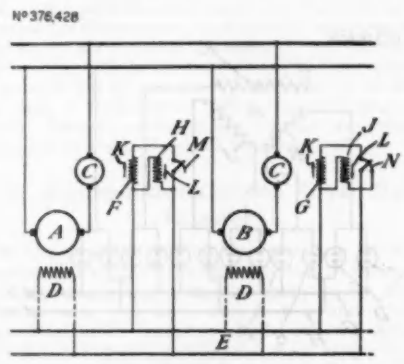
This invention has reference to the automatic voltage control of A.C. machines by means of one or more diodes. A is the alternator to be controlled. The alternator has its terminals connected to the primary B of a transformer, the secondary of which supplies the cathode of a diode C through a choke coil D with an iron core. The tube C is connected in parallel with the



field coil E of the alternator. The field current and the anode current for the tube C are supplied from a source of direct current F through a resistance G. Under normal voltage conditions the core is designed to work on the saturated part of the magnetisation curve. Since the core of the choke coil D is saturated, the relative potential fluctuations at the cathode will occur to an intensified extent. The degree of amplification thus obtained depends on the saturation and of that part of the total voltage in the heating circuit that is taken up by the choke coil.—*July 7th*, 1932.

376,428. May 20th, 1931.—MEANS FOR REGULATING THE INDIVIDUAL MOTORS OF MULTI-MOTOR DRIVES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to means for regulating the individual motors of multi-motor drives, in particular for paper-making machines, in which the regulation is effected by altering the

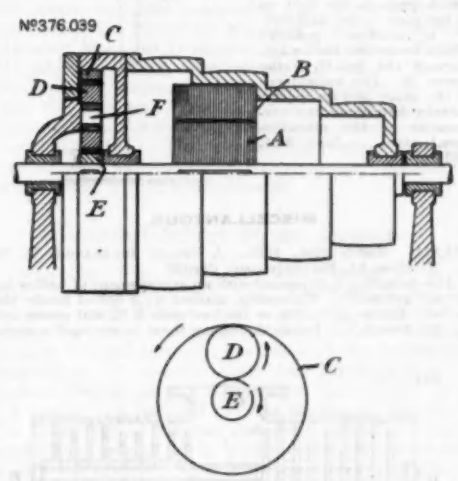


armature voltage supplied to all the motors by introducing an additional voltage, in the same direction as the armature voltage or in the opposite direction, from an auxiliary machine. The armatures of two individual motors A and B are fed from the network of variable voltage with the interposition of auxiliary generators C. The motors A and B each have an excitation winding D, which is connected to a network E of constant voltage through regulating devices, which are indicated by the dotted connection of the exciting coils with the network E. The fundamental excitation of the machines C is supplied by the coils F and G respectively, whilst the auxiliary excitation is generated by a coil H or J. The fundamental excitation acts in the direction K and the auxiliary excitation in the direction L. In the left-hand example the auxiliary coil H is connected directly to the network E, whereas in the circuit of the fundamental excitation coil F there is a regulator M, with which the exciting current can be regulated. If the exciting current is weakened, then the oppositely directed auxiliary field remaining with unchanged strength will gradually predominate and the voltage supplied by the auxiliary machine C will be brought to zero and slowly reversed. In the right-hand example, the auxiliary winding J is connected to the free end of the regulator N, so that upon operation of the regulator the auxiliary excitation and the fundamental excitation are regulated in opposition to each other. This connection has the advantage that in the various positions of the regulator lever the influence of the two coils is of varying intensity, and, in the final positions, can be so far changed that the influence of one coil is practically cut out.—*May 20th*, 1932.

TRANSMISSION OF POWER.

376,039. July 30th, 1931.—STEPPED BELT PULLEYS HAVING A BUILT-IN ELECTRIC MOTOR, Himmelwerk A.G., of Tübingen, Württemberg, Germany.

In accordance with this invention, an electric motor is incorporated in a stepped pulley, which runs at a considerably lower speed than the motor. The inner armature A, which preferably constitutes the field system, is mounted on the shaft, and is connected by leads passing through the shaft to slip rings

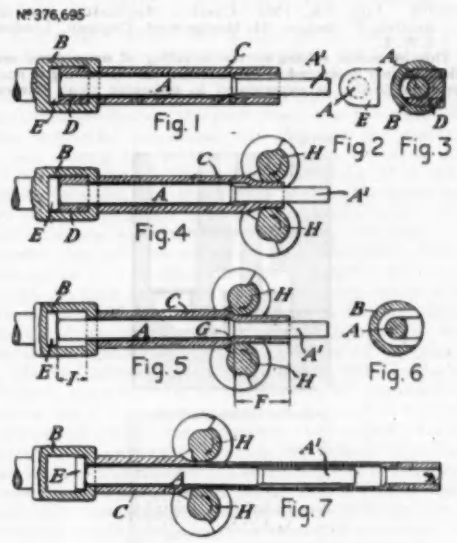


outside one of the bearings. The outer member B of the motor forms a short-circuited armature. At C there is an internal gear which engages with a gear wheel D, which meshes with a gear wheel E secured to the shaft. The intermediate wheel D is mounted on a fixed pin F. In some cases it is desirable that two speeds should be available, and the shaft can be used, for example, for a quick return of work on a machine or for driving auxiliaries, such as pumps.—*July 7th*, 1932.

MACHINE TOOLS AND SHOP APPLIANCES.

376,695. April 18th, 1932.—APPARATUS FOR THE PRODUCTION OF METAL TUBES WITH INWARDLY THICKENED ENDS, Mannesmannröhren-Werke, Ide, Berger Ufer, Düsseldorf, Germany.

A Pilger mandrel A is provided with a head E, which is arranged to be located within the hollow head B of a mandrel holder, and at the commencement of the rolling operation, in accordance with the invention, the head E is maintained in abutting relationship with the rear face of the hollow head B by means of a fork-shaped insert member D, which is placed in position between the mandrel head E and the outer end of the



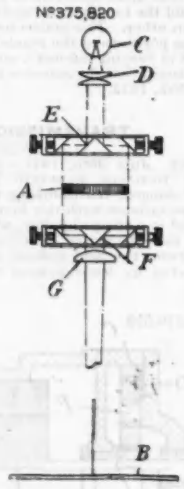
head of the holder B, the insert member D extending partially around the mandrel A, as illustrated clearly in Fig. 3. The bloom C is placed over the mandrel so as to abut at one end against the head of the holder B and extends at its other end over a portion A^1 of the mandrel which is of reduced diameter. The initial rolling operation by means of the Pilger rolls H, as illustrated in Fig. 4, rolls the bloom C into contact with the reduced portion A^1 of the mandrel to produce the thicker end of the tube. The insert member D is then withdrawn from the holder B, so that the mandrel A is free to move relatively to the holder by an amount which is indicated at I in Fig. 5, the mandrel head E providing a lost motion connection between the

mandrel and the holder B. After the removal of the insert member D the rolling operation proceeds until the thicker end of the tube has been completed to the extent indicated at F in Fig. 5, and thereafter the transitional portion G between the thicker and narrower portions of the tube wall is rolled, and is followed by the rolling of the thinner portion of the tube wall by the ordinary pilgering process. During the rolling of the transitional portion and the thinner wall of the tube, the mandrel A is gradually moved to the right in Figs. 5 and 7 relatively to the holder B until the mandrel head E abuts against the outer end of the holder, as indicated in Fig. 7.—*July 14th*, 1932.

MEASURING AND TESTING INSTRUMENTS.

375,820. March 30th, 1931. —Apparatus for Testing, Comparing, and Gauging Dimensions, W. H. Smith and the Precision Tool and Instrument Company, Ltd., 72, Newington Butts, London, S.E. 11.

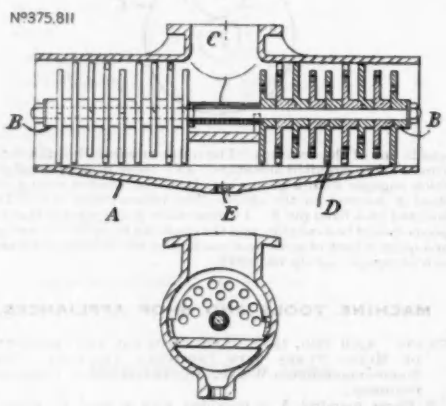
This instrument is used for comparing manufactured pieces, such as a gear wheel A with a master pattern, which is arranged on the screen B. C is a source of light, D a condenser, and E a reflector, which projects the light on to the piece to be examined. F is another reflector which transmits the image, through the lens G, to the screen B. The coincidence of the image and the master pattern determines the correctness of the manufactured piece. — *June 30th*, 1932.



MISCELLANEOUS.

375,811. March 31st, 1931.—A Steam Separator, T. G. Thomas, 63, Pencisely-road, Cardiff.

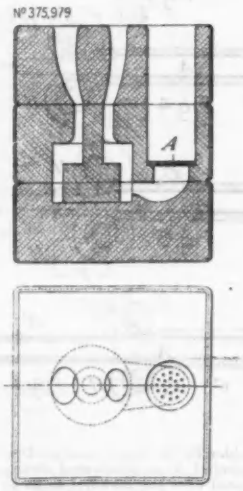
This invention is concerned with an arrangement of baffles for drying wet steam. The casing, marked A, is bolted inside the boiler. The steam enters at the two ends B B, and passes out by the branch C. Inside the casing there is arranged a series



of baffles D, which are threaded on to a square rod. The baffles have square holes for the purpose. For half its circumference each baffle is reduced in diameter, and it is also perforated, as shown. The baffles are threaded on to the rod set, mutually at an angle of 90 deg., so that the steam is given a helical direction. The water thrown out is drained off at E.—*June 30th*, 1932.

375,979. June 9th, 1931.—Casting Magnesium and its Alloys, F. Badger, 14, Grange-road, Clapham, London, S.W. 4.

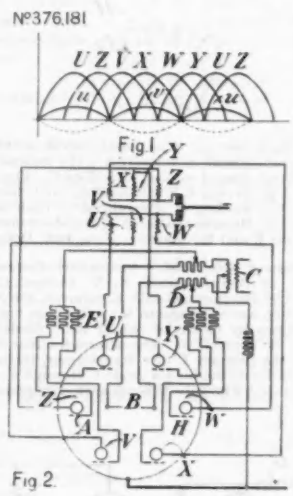
This invention relates to the founding of magnesium and alloys mainly composed of magnesium. In the casting of such metals difficulty is experienced in obtaining clean flawless



castings, due partly to the highly oxidisable character of the metal itself and partly to the inclusion of the fluxes which are difficult to eliminate during the pouring process. Further, the oxidation which occurs to some extent during the pouring of the metal creates impurities which are carried with the metal into the mould and cause defects in the casting. This oxidation is decreased to some extent with an increase in the rate of pouring, but too rapid a rate of pouring may result in mechanical damage to the sand of the mould and core. A plug of perforated refractory material is inserted at or near the bottom of the runner, and in the case of more than one runner a plug should be inserted in each. The relative size of the plug and perforations may vary within wide limits, and as an example a disc-like plug of moulding sand may be 2in. diameter, $\frac{1}{2}$in. thick, and have nineteen evenly spaced holes of about $\frac{1}{16}$in. diameter. The use of a plug such as described breaks up the surface tension of the magnesium metal, which is due to a skin or film immediately formed on such metal when passing through the atmosphere between the pot and the mould. After its passage through the plug the metal is kept in an inert atmosphere by the use of SO_2 in the mould, and no further skin is formed, and the breaking up of this surface tension or skin, in addition to minimising any attack from contact of the metal with the sand of the mould, also enables it to flow more readily into the thin sections and sharp angles of the mould and produce cleaner and better defined castings. The plug is shown at A in the drawing.—*July 7th*, 1932.

376,181. December 22nd, 1931.—Mercury Vapour Rectifiers, Aktiengesellschaft Brown Boveri et Cie., of Baden, Switzerland.

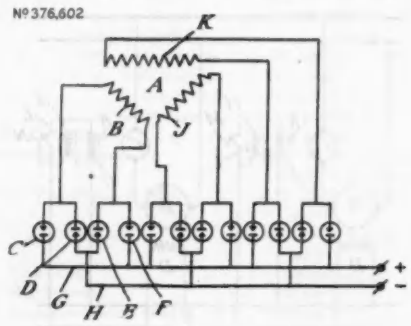
It is known that in rectifiers with long sleeves surrounding the anodes or with grids having a strong blocking action in front of the anodes, the outgoing current of the anodes starts with difficulty or not at all. On the load on the rectifier diminishing, it has also been found that the anodes ignite in an irregular manner or that the arc breaks. It is known that by connecting the grids or the grids and sleeves to voltages which are positive with respect to the cathode, the ignition of the anodes is facilitated. This positive voltage is taken from a separate source of continuous or alternating current. For conveying the voltage to the grids of each anode special insulating bushes are required. According to the invention, all these disadvantages are overcome. In Fig. 1 the voltage succession of the anodes is marked U V W, and the voltages of the exciter phases are marked *u* and *v*. The exciter phase *u* may lag with respect to the anode voltage U by 0 to 30 deg. electric. If, therefore, the grids of the anodes associated with the phases U Z V be connected with the exciter voltage *u*, and those of the phases X W Y with that of *v*, it will be seen that all the grids are positively charged at the moment of ignition of the main arc. A diagram of connections



for carrying out the invention is shown in Fig. 2. H is a rectifier. In front of the anodes are placed the grids A. The anodes are fed from the secondary winding of the feeding transformer of the rectifier. B are the exciter anodes which are fed from the two-phase exciter transformer C over resistances D. The grids A are connected over resistances E to tappings of the resistances D in the exciter circuit. Instead of being connected to the resistances D, the grids may be connected over the resistances E to the exciter anodes. The available positive voltage is, of course, greater when the grids are connected to the resistance in the exciter anode circuit. If the resistances connected in series with the grids are housed in the rectifier casing, and the grids connected with the resistances in the exciter circuit, only two insulated bushings are required for all the grids and when the grids are connected to the exciter anodes themselves insulated bushings leading to the grids are eliminated. In place of a two-phase transformer for providing the excitation, a three-phase transformer may be used, in which case grids of a six-phase rectifier must be subdivided into three groups.—*July 7th*, 1932.

376,602. November 6th, 1931.—Rectifying Apparatus for Multi-phase Rectification, N. V. Philips' Gloeilampenfabrieken, Emmasingel 13 D, Eindhoven, North-Brabant, Netherlands.

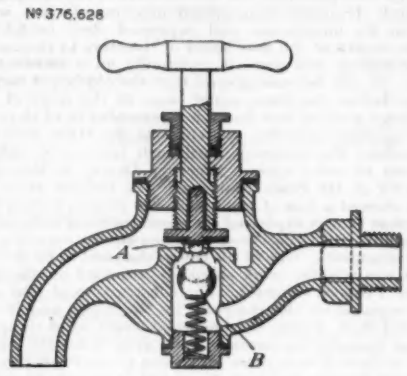
The invention relates to rectifying apparatus for multi-phase rectification, more particularly for the rectification of high voltages. According to the invention, it is possible to divide twice the amount of power over a number of rectifiers than is



possible with the known circuit-arrangements without losses in resistances or choke coils being produced. A denotes the delta connected secondary side of a three-phase transformer. Each end of each phase winding is connected to two rectifiers. Thus, for example, one of the ends of a winding B is connected to rectifiers C and D, and the other end to rectifiers E and F, whereas the whole constitutes a Grätz circuit-arrangement in which the conductors G and H lead to D.C. terminals. The other phase windings J and K are connected to similar groups of rectifiers, the D.C. side of which is likewise connected to the conductors G and H. It is evident that it is possible to proceed in a similar manner when the secondary side of the transformer has a different number of phases.—*July 14th*, 1932.

376,628. December 7th, 1931.—Taps or Valves, S. H. Price, Fairview, Bective-road, Putney, London, S.W. 15.

This idea needs hardly any description, in view of the drawing. The valve is ordinarily closed on the seating A, but should it



be necessary to remove it for re-washering, or any other reason, the ball B rises and temporarily closes the water passage.—*July 14th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

FRIDAY, AUGUST 19TH, TO MONDAY, SEPTEMBER 19TH.

Institution of Mechanical Engineers.—Summer visit to Canada.

SATURDAY, AUGUST 20TH.

Institution of Municipal and County Engineers.—North Wales District meeting at Penmaenmawr. Meet at Penmaenbach works, Penmaenmawr. 2.15 p.m.

WEDNESDAY, AUGUST 31ST, TO WEDNESDAY, SEPTEMBER 7TH.

British Association for the Advancement of Science.—Annual meeting at York. President, Sir J. Alfred Ewing, F.R.S. Particulars may be obtained on application to the secretary, British Association, or to the hon. local secretaries, British Association, The Guildhall, York.

SATURDAY, SEPTEMBER 10TH.

Institution of Municipal and County Engineers.—Eastern District meeting to be held at Great Yarmouth. Assemble at Town Hall, Great Yarmouth, 10.30 a.m.

MONDAY, SEPTEMBER 12TH.

Institute of Metals.—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual autumn lecture, "Corrosion Fatigue in Metals," by Dr. H. J. Gough. 8 p.m.

MONDAY TO THURSDAY, SEPTEMBER 12TH TO 15TH.

Iron and Steel Institute and Institute of Metals.—Joint autumn meeting in London. For programme see page 119.

TUESDAY TO SATURDAY, SEPTEMBER 13TH TO 17TH.

International Foundry Congress.—Paris.

SATURDAY, SEPTEMBER 24TH.

All-British Exhibition.—Copenhagen, Denmark, Opening.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Dr. Oscar Faber, M. Inst. C.E., informs us that his address is now Romney House, Marsham-street, Westminster, S.W. 1.

Mr. William Taylor Kitching, managing director of John Fowler, Ltd., of Sheffield, has been appointed general manager of the Ironworks Department of Newton, Chambers and Co., Ltd., Thorncliffe, near Sheffield.

Ships of the Merchant Navy.—We have received from our contemporary journal, the *Shipping World*, a reprint in a handy book form, published at 2s. 6d., of the series of articles which recently appeared in the *Shipping World* under the heading of "Ships of the Merchant Navy." The articles deal with liners, intermediate liners, cargo liners, tankers, general traders, and refrigerated vessels, and give an analysis of their owners, builders, number, gross tonnage, machinery, average age, and average speed. One of the objects of making the analysis was to forecast the possible demand for new ships in the near future. It is suggested in the articles that the dearth of work in British shipyards is only a passing phase, which will be succeeded shortly by a flow of orders for ships of all types. The position is examined in some detail. It is shown that the outlook for the shipbuilding industry, so far as British orders are concerned, is not as bad as is sometimes suggested. With a readjustment of working conditions so as to bring the industry into line with competitors on the Continent, there is reason, moreover, to anticipate that orders from the Continent in at least as large a volume as in the past will be secured, for there is a large amount of old tonnage under foreign flags. The statistical analysis, contains much original and valuable work, which is to be recommended to all interested in the present and future position of the British shipping trade.

A Seven-Day Journal

German Shipbreaking Scheme.

IN a Journal note of March 18th last we outlined the proposals for the reorganisation of the two principal German shipping groups with Government aid, and a suggested plan for State assistance in the breaking up of obsolete tonnage. Under an agreement recently concluded between the companies and the German Government, a sum of 12 million marks is to be placed at the disposal of the companies to facilitate the scrapping of redundant tonnage. The two principal companies, the Norddeutscher Lloyd and the Hamburg-Amerika Line, are to receive 6 million marks each, the remaining 6 millions being divided between the Hamburg Süd Amerikanische Line, the Hansa Line, and other smaller shipping companies. A company is to be formed to allot the breaking-up contracts, and to dispose of the material, and it is expected that the scheme will find employment for 1000 to 1500 workers. for a period of twelve to eighteen months. The sum allotted by the Government works out at the rate of about 30 marks per gross ton, an aggregate of 400,000 tons being under consideration. It has recently been pointed out that the British mercantile fleet contains between 600 and 700 ships built before the war, representing three to four million gross tons. Much of this tonnage is now obsolete, and there are many who think that a scheme similar to that outlined above could with advantage be adopted in this country.

L.M.S. Steel Works at Crewe.

LAST Thursday, August 11th, the L.M.S. Railway Company announced that its steel works at Crewe would be closed on September 30th, as they can no longer be operated economically. The company issued an official statement, from which we extract the following:—"The company is faced with the alternatives of incurring heavy capital and renewal expenditure for modernisation, or ceasing to manufacture and obtaining their supplies from the steel producers. In view of the capacity of the existing steel plants in the country, and the national importance of economic production of steel in Great Britain at the present time, the expenditure necessary to modernise the forge and rolling mills cannot be justified. It is with great regret that the staff have been notified that the steel works at Crewe will be closed on September 30th. The displacement of a large number of men is inevitable, and as in the majority of cases the decision means that there is no likelihood of further employment by the company, owing to this particular branch of the company's activities being entirely discontinued, the company has decided to give such staff a retiring gratuity which will have regard to their length of service. This decision does not mean that there is any intention on the part of the company to abandon Crewe as a centre for railway activity, as the development of the company's arrangements will, it is hoped, enable certain subsidiary workshop activities to be concentrated at Crewe."

A Teleprinter Service in London.

ON Monday, August 15th, a teleprinter service, which enables any kind of message to be typewritten between the offices of any two telephone subscribers at any distance from each other was opened in London. It is intended gradually to extend the system to provincial towns and to include a trunk service. During the past year a great deal of attention was paid to the development of the apparatus, and the General Post Office has now made arrangements to meet the demand for a large number of teleprinters in London. Sir Kingsley Wood, the Postmaster-General, recently described the instrument as a modern miracle which would undoubtedly assist trade and industry. When a subscriber desires to send an important communication to another office he rings up on the telephone in the ordinary way and when the subscriber at the other end answers he is asked to switch over to the teleprinter. The message is then typed out at the caller's office and is recorded simultaneously in script at the distant office. Subscribers to the new service can rent a teleprinter with the necessary switch to change over from the telephone to the printing instrument at an annual rental of £65, which covers the cost of istallation and maintenance.

The United States and British War Inventions.

ON Thursday, August 11th, the United States Commission, which has been hearing compensation claims advanced by inventors in respect of the use of their inventions during the war, concluded its sittings. The Commission will visit Paris towards the end of the month to hold a sitting in connection with one of the claims, and will later resume its sittings in Washington. At the closing sitting Mr. K. E. Shelley, on behalf of the British Crown, said that all the Crown was concerned to do was to secure a hearing for the claimants before the representatives of the United States Government, and to afford the claimants information. Although it was much to the interest of the British Crown that the United States Government should be possessed of the knowledge of these inventions, that, he held, should not detract from any award being made to the inventors. Mr. Shelley further submitted that the United States Government might treat the British Government as an agent for the inventor, previously undisclosed, but now disclosed as such, and that the matter should be dealt with as if the inventors had actually handed over their inventions to the United States. Before adjourning the Commission sitting, the Chairman, Lieut.-Colonel Joseph McMullen, expressed appreciation of the manner in which the Admiralty, counsel, and claimants had co-operated with the Commission in the carrying out of its task. It was never the intention of the Crown to hand over the inventions as being something they had in their legal possession or control, and something for which they could claim compensation. Although a claimant might happen to be a service inventor, yet, in his transaction with the United States Government, he ought to be regarded as if he were independent of the British service and was an outside inventor.

The Late Deputy Chief Inspector of Factories.

ENGINEERS, both in England and Scotland, will learn with deep regret of the death of Mr. Harry James Wilson, Deputy Chief Inspector of Factories, which took place at Orpington on Thursday of last week. Mr. Wilson, who was only sixty-two, was born at Baldavie, in Banffshire, and received his education at Aberdeen Grammar School and at Gordon's College. In 1892 he was appointed H.M. Inspector of Factories and served at Leeds, in Lancashire, at Dundee, and at Newcastle-upon-Tyne, and was for several years in charge of the North-East of England district. In 1907 he was promoted to be Deputy Superintending Inspector for Scotland, and in 1916 was made Superintending Inspector. He took a particular interest in the prevention of accidents in shipyards and collaborated in writing two reports on this subject. He was also a member of committees on the timbering of deep excavations, and check weighing in the iron and steel trades, upon which subjects, with his assistance, valuable reports were published. In 1917 he was appointed a Commissioner for National Service in Scotland, and he also served on the West of Scotland Armaments Committee. After the war, Mr. Wilson was decorated with the Order of the British Empire in recognition of his national services. In 1923 he was appointed Deputy Chief Inspector of Factories at the Home Office, a position which he held with distinction and from which he was shortly to have retired after forty years of service.

Oil Engines for Basrah Power Station.

AN order has been placed by the Crown Agents for the Colonies with Ruston and Hornsby, Ltd., of Lincoln, for five oil engine-driven generator sets which are to be installed in the new power station of the Basrah Port Directorate at Basrah, Iraq. The object of the new station is to provide current for the port and the locality at the lowest possible cost. Two of the five new sets, which will supersede the present steam-driven plant, will be 440 B.H.P. eight-cylinder engines operating on the Ruston airless injection principle, coupled to 250-kW alternators, two further engines being 220 B.H.P. four-cylinder units coupled to 125-kW alternators, while the remaining unit will be a 120 B.H.P. four-cylinder engine coupled to a 65-kW alternator. The three-phase, 50-cycle, 400–440-volt alternators are to be supplied by Lancashire Dynamo and Crypto, Ltd., of Manchester and London, and the whole series of generators will be arranged to supply lighting and power circuits in parallel and to deal with loads up to 815 kW capacity. In addition to the main sets detailed above the contract covers the supply of exhaust and cooling water arrangements, compressed air starting equipment, an emergency lighting set, and lastly purifying plant for fuel oil and lubricating oil, which will be made by Hopkinsons, Ltd., of Huddersfield. The consulting engineers for the Basrah power-house scheme are Messrs. Preece, Cardew and Rider, of Westminster.

The Reorganisation of the Royal Mail Group.

THE registration of the new company of Elder Dempster Lines, Ltd., on Monday last, to take over the shipping services formerly operated by Elder, Dempster and Co., Ltd., the British and African Steam Navigation Company, Ltd., and the African Steamship Company, marks the final stage in the reorganisation of the Royal Mail Steam Packet Company, Ltd., under the scheme announced early in March. The company, which has a registered capital of £2,500,000, will acquire and amalgamate the undertakings or parts of the undertakings of five companies in the African trade, the three above-mentioned and the two smaller groups of the Elder Line, Ltd., and the Imperial Direct Line, Ltd. The number of ships taken over amount to fifty-five in all. The directors of the new company are Mr. Richard D. Holt, the head of Alfred Holt and Co.; and the Hon. L. H. Cripps, his co-director; Mr. Picton Hughes Jones, a director of the existing Elder, Dempster Company; and Mr. Gerald F. Torrey, who is on the board of several of the Royal Mail companies, including all those whose interests have been amalgamated under the new company. The head office of the company will be at Colonial House, Water-street, Liverpool.

The Metz-Thionville Canal.

ALTHOUGH only 19 miles long, 30ft. deep, and designed for 300-ton barges, the Metz-Thionville canal, which was formally opened by President Lebrun on Sunday last, August 14th, is an important development. It runs through one of the most important French industrial districts and serves the iron mines in the locality. Plans for such a canal have been in existence since 1867. The 1870 war prevented its construction, and it was not until 1928 that Government approval for the scheme was obtained. Work was begun early in that year and water first entered the canal towards the end of 1931. The canal has cost something over £1,600,000. In addition to the President, Monsieur Herriot, the Prime Minister, Monsieur Dalandier, the Minister for Public Works, and other Government officials, attended the opening ceremony. Monsieur Dalandier said that the complete canalisation of the Moselle from Thionville to Coblenz presented difficulties, but was not impossible. The French Government would put in hand without delay the necessary extensions of the canal within France itself.

Welded Boiler Steam Drums.

SPEAKING this week on the occasion of a visit of engineers to the Renfrew works of Babcock and Wilcox, Ltd., for the purpose of inspecting the company's new fusion welding process, Colonel Greenly, chairman of the executive, referred to the reasons which had led to a demonstration being given. Experience during the last few years had brought to the notice of engineers the behaviour of riveted pressure vessels in certain conditions owing to a combination of corrosion and metal fatigue. This experience had emphasised the desirability of bringing into use pressure vessels so constructed that the inherent stresses existing in riveted constructions were avoided. Solid-forged drums fulfilled that requirement, but they were expensive, and for pressures ranging up to, say, 550 lb. per square inch it was difficult on economic grounds to justify the high capital expenditure arising from their employment. The Babcock organisation now claimed to prove that by the use of a mechanically controlled electric arc, suitably shielded, vessels could be produced with a regularity in quality of workmanship superior to riveting technique of the most advanced class. Examination by the penetration of X-rays had been proved to be entirely adequate for testing purposes, and by the development of a suitable method of radiographic examination it was now possible thoroughly to explore every cubic inch of weld metal deposited and further to produce X-ray photographs of each part of every welded seam in a drum.

The Glasgow Electricity Undertaking.

NOTWITHSTANDING the decline in the demand for electric power for industrial purposes, the Electricity Department of the Glasgow Corporation was one of the most successful of the trading undertakings of the municipality during the past year. As the result of the industrial conditions the demand for electric power during the last two years has fallen off by 17,000,000 units. The reduction during 1931 was 6,000,000 units, but the decline was so far balanced by an increase in the domestic consumption that the net reduction was only 1,000,000 units. By reason of careful financial management the Electricity Committee has now found it possible to make a reduction of ½d. per unit in the primary rate to non-residential consumers. The industrial depression has naturally slowed down the expected annual growth of the department and has laid idle a section of the plant in the Dalmarnock generating station, but Ex-Bailie Holmes, the Convener of the Electricity Committee, states that the consumers can look forward to further substantial reductions whenever the output of the department increases. In the industrial field the rates now being charged for electricity are lower than those charged prior to the war. The domestic user has also been encouraged in every possible way, with the result that the department is now said to have a larger domestic consumption than that of any similar undertaking in the country. Under the Corporation's hire purchase schemes 40,000 houses have been wired and 24,000 electrical appliances, such as cookers, fires, water boilers, &c., have been installed on consumers' premises. But Ex-Bailie Holmes believes that there is still a very wide field for an increased domestic use of electricity and that in due course all households within the Corporation's area of supply will be served. During the past year the department was able to show a surplus of £45,813.

THE IRONBRIDGE POWER STATION OF THE WEST MIDLANDS JOINT ELECTRICITY AUTHORITY

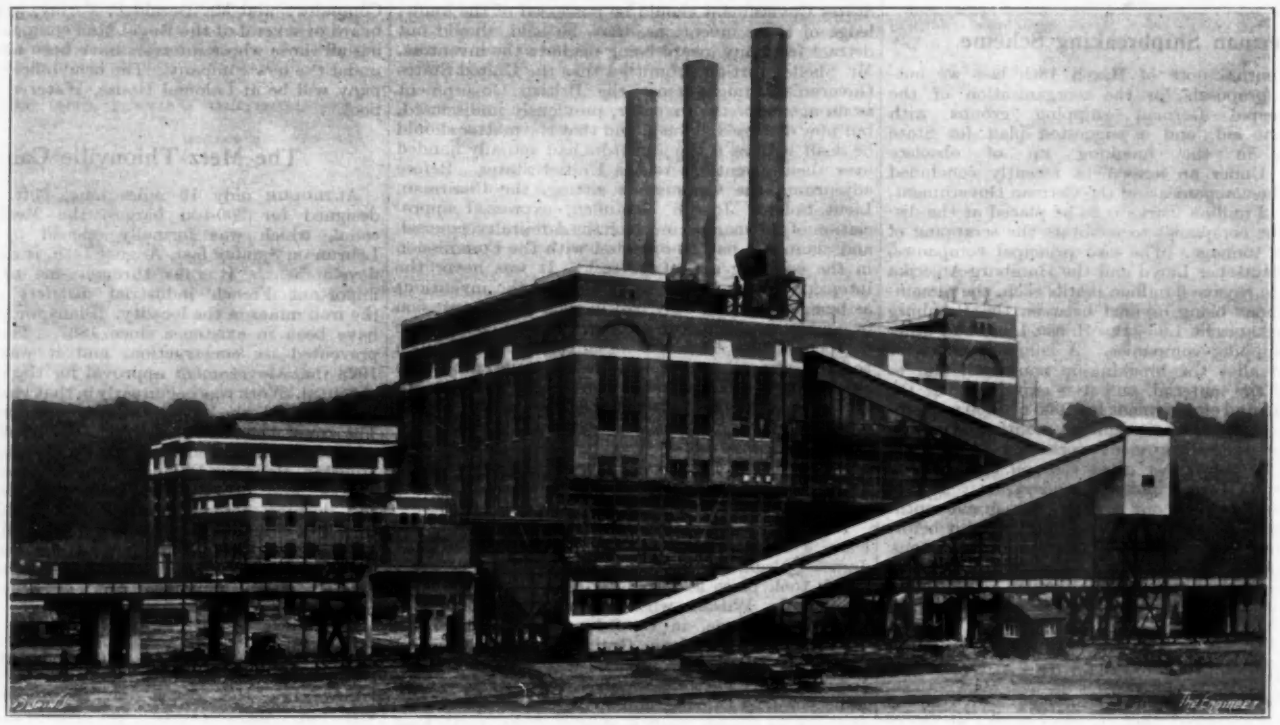


FIG. 1—GENERAL VIEW OF POWER STATION AND COAL HANDLING PLANT

The Ironbridge Power Station.

No. I.

SITUATED at Buildwas, about one mile west of Ironbridge, the new power station of the West Midlands Joint Electricity Authority relies on the river Severn for circulating water and on the Great Western Railway for the supply of coal. As originally planned, it was intended to have a maximum capacity of 125,000 kW, made up of five 25,000-kW sets, but with the passing of the 1926 Act and the advent of the Electricity Board, it was decided that the ultimate capacity should be 200,000 kW from four 50,000-kW units. While the Authority proposed to erect its own transmission lines for supplying electrical energy to its large system in the east of the area and for linking up the station with its existing stations at Wolverhampton, Walsall, West Bromwich, and Ocker Hill, the establishment of the Central Electricity Board also led to the decision that "Grid" lines should be taken to some of those points. Consequently the only lines leaving Buildwas that are actually owned by the Authority are those for supplying the area in Shropshire which has hitherto been undeveloped. As soon as the new plant is in full working order, the Authority is under an agreement to purchase the Shrewsbury generating station and to give a bulk supply to the Corporation, a partial supply already being given by the Authority from the Stourport station of the Shropshire, Worcestershire and Staffordshire Electric Power Company. The civil engineering work has been completed for the entire 200,000-kW station, but the present buildings are only designed for half that capacity, and the plant that has been installed is capable of developing 50,000 kW. The architectural features of the building—Fig. 1—are very pleasing and reflect considerable credit on the Authority's advisory architect, Mr. Ivan Daughtry.

THE SITE.

As shown in the map, Fig. 2, the ground purchased by the Authority is considerably in excess of that required by the station (see Figs. 10 and 11 and 13 on page 184), which has been built on a strip of land north of the railway, the land on the south being reserved for a possible future housing estate. The road to the west of the station, it will be noted, connects directly and in a straight line with a bridge that has been constructed by the Authority across the river, the flow of which is intercepted for circulating water purposes before the water passes round the bend immediately to the west of the bridge, and this has necessitated placing the circulating water pumphouse some little distance to the west of the power station. Surveys that were made before the building work was begun showed that there was an ample flow of water in the river, even after long periods of dry weather.

Access to the site by road is difficult, as all approaches involve steep gradients on the second and third-class roads, but there are ample railway facilities for the delivery of heavy plant. The bridge shown in Fig. 3 and in Fig. 12 on page 184, consists of one main span of 160ft. and three approach spans of about 54ft. It is designed to take a traction engine with a load of 6000 lb. on each front wheel and 14,000 lb. on each back wheel, with a 7ft. track and 12ft. between the centres of the axles. The remainder of the structure can be loaded to the extent of 85 lb. per square foot and the complete bridge has been built to take two lines of traffic. It was considered that these conditions would provide for any loads likely to be put on the bridge, which was built by Braithwaite and Co., Ltd. When constructing the temporary structure upon which to erect the main bridge span, piles 6in. in diameter attached to screws were driven into the bed of the river to a depth of approximately 4ft. to 7ft. at positions under the panel points of the bridge and by bracing these piles by means of rods to horizontal channel members clipped to the piles, a construction was obtained that presented a minimum amount of obstruction to *débris* floating down the river and to some extent eliminated the formation of a refuse barrage which might have had a tendency to flood the adjoining site during the winter. The piles were screwed sufficiently to allow timber parkings to be attached to the caps to permit the necessary adjustment. For the purpose of screwing a capstan wheel was dropped on to the screwing key attached to the upper portion of the pile, and a rope passing round the wheel was attached to a 5-ton hand winch on the land. Partly on account of the fact that electrical energy was not available when the work was in progress, and partly with a view to economy, the piles were driven by hand.

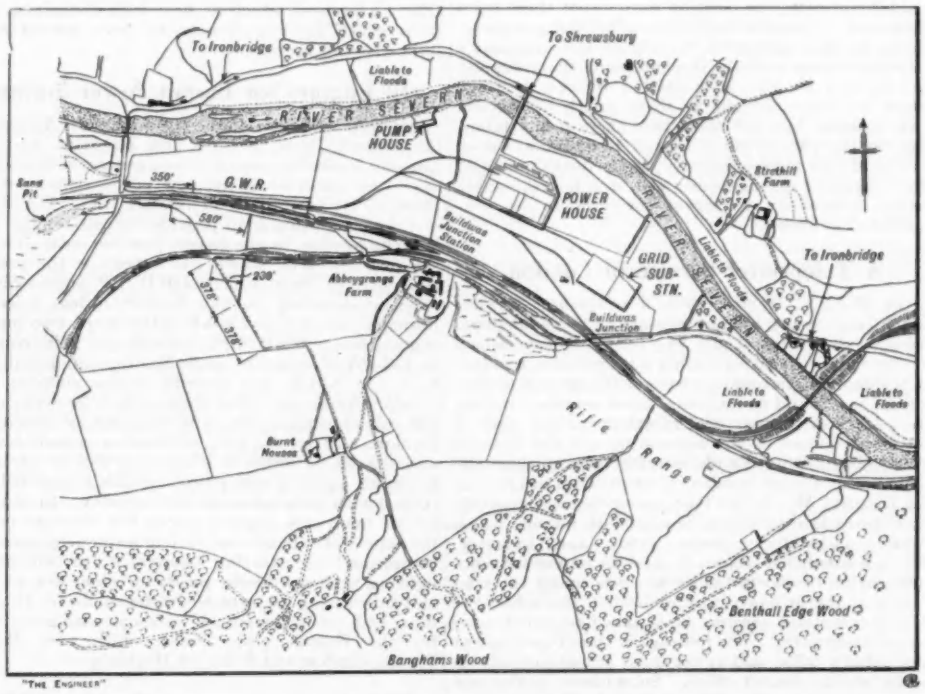


FIG. 2—MAP OF POWER STATION SITE

The steel troughing which runs longitudinally along the bridge is filled with weak concrete, which is covered with two layers of asphalt, covered, in turn, with the concrete road proper. There are joints at every 20ft., and expansion joints are provided in the roadway at the bridge bearings. At the south side of the bridge a standard U abutment is provided, but that on the north side is of special design, as shown in Fig. 4. The subsoil upon which this abutment was constructed consists of shale sloping at an angle of approximately 10 deg., and as it was known that in the past the land at this point had been liable

to slip, the special abutment illustrated was adopted. Two holes were dug, 25ft. long in the direction north to south, 7ft. 6in. west to east, and about 30ft. deep, and as the lower portion of these holes was in good clay or shale, only the top portion was shuttered. In these holes 12ft. concrete bases for the walls were provided, and on top of these the reinforced concrete walls, 23ft. long and 4ft. wide, were placed. To obtain the maximum toe pressure, the earth pressure to be resisted by the north vertical face of the abutment was considered, and taking into account the weight of the bridge fully loaded and the expansion thrust transmitted through the bearings, the toe pressure obtained was 4·7 tons per square inch. As the abutments were on very tough shale, it was considered that this pressure would give an ample margin of safety, especially as it had the assistance of the bank between the abutment and the river.

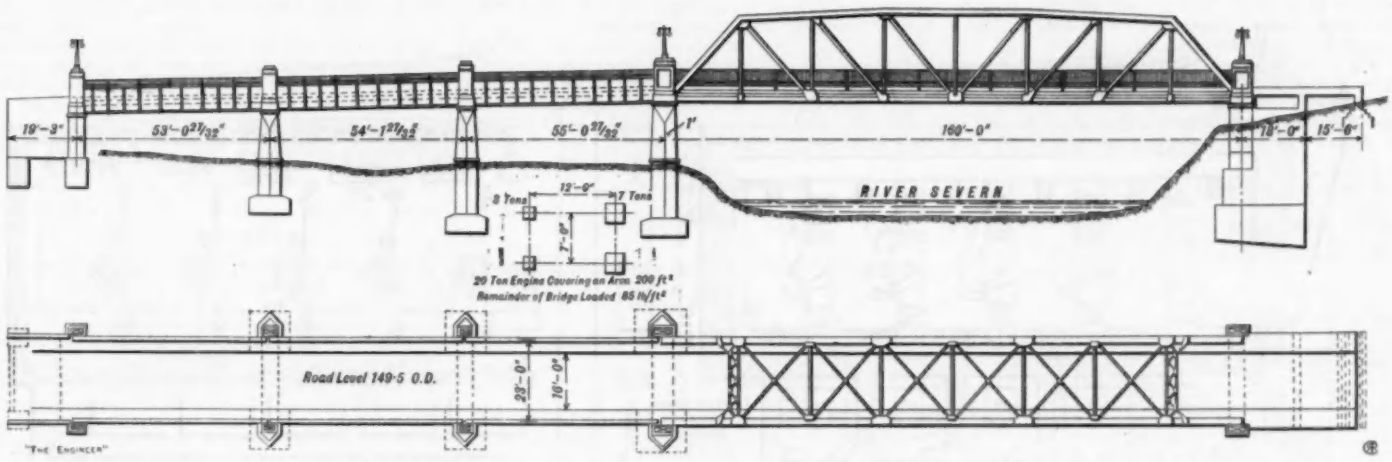


FIG. 3—PLAN AND ELEVATION OF BRIDGE ACROSS THE RIVER SEVERN

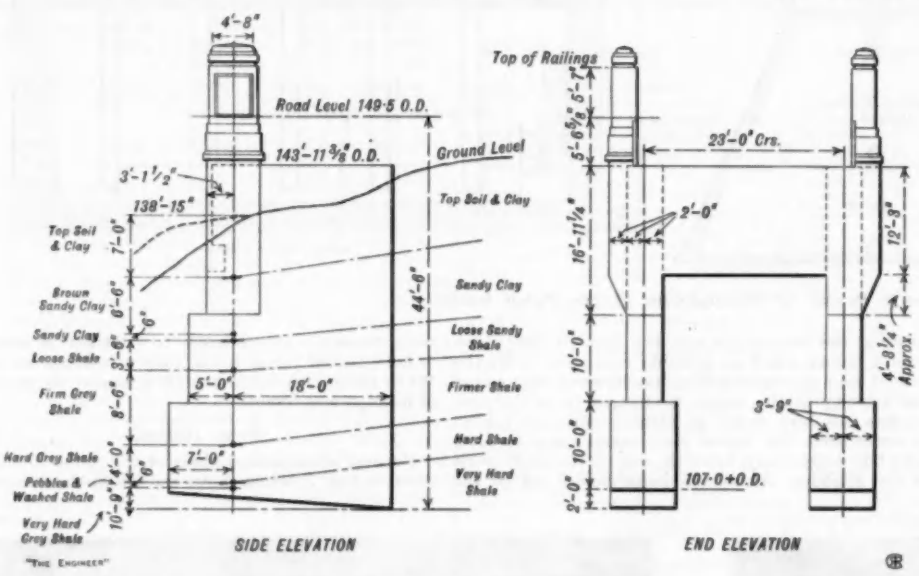


FIG. 4—BRIDGE ABUTMENT AT NORTH END

that the level reached in 1795 was not likely to recur, especially in view of the fact that the Liverpool Corporation now draws considerable quantities of water from lake Vyrnwy, which is connected to the Severn. Moreover, since 1795, when the Severn was navigable with weirs and locks, the whole character-

when the water rose from the normal summer level of 118 to 142 O.D., and with a view to eliminating all possible risk of flood it was originally proposed to construct the main floor levels at 144 O.D. But, after careful investigations and discussions with various local and county authorities, it was concluded

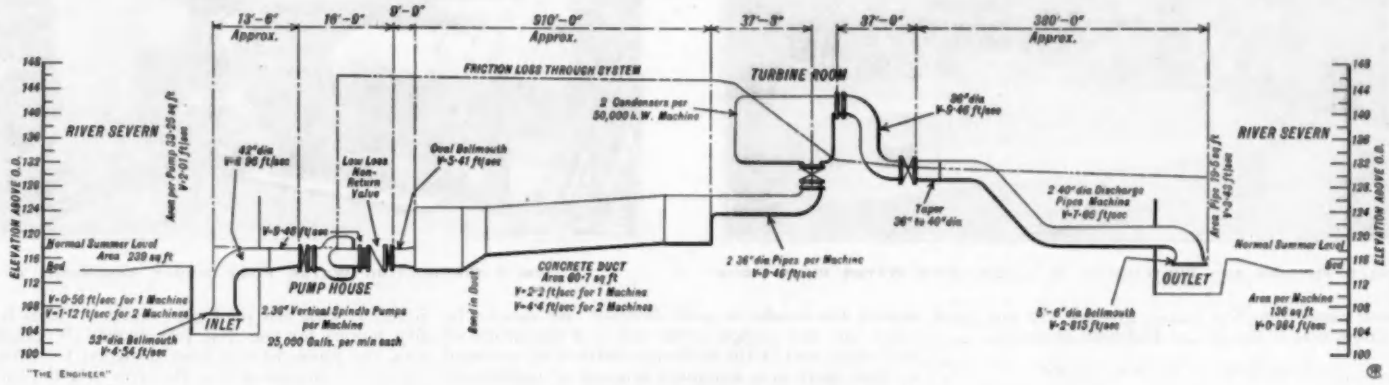

13'-6" Approx.
16'-0"
9'-0"
910'-0" Approx.
37'-9"
37'-0"
380'-0" Approx.
FRICTION LOSS THROUGH SYSTEM
TURBINE ROOM
RIVER SEVERN
2 Condensers per 50,000 h.W. Machine
36" dia V-9·46 ft/sec
42" dia V-6·96 ft/sec
Low Loss Non-Return Valve
Oval Bellmouth V-3·41 ft/sec
Area per Pump 33·25 sq ft V-3·01 ft/sec
Normal Summer Level Area 239 sq ft
V-0·56 ft/sec for 1 Machine
V-1·12 ft/sec for 2 Machines
52" dia Bellmouth V-6·54 ft/sec
INLET
PUMP HOUSE
2.30" Vertical Spindle Pumps per Machine
35,000 Galls. per min each
Bend in Duct
CONCRETE DUCT Area 60·7 sq ft V-2·2 ft/sec for 1 Machine V-4·4 ft/sec for 2 Machines
2 36" dia Pipes per Machine V-9·46 ft/sec
Taper 36" to 40" dia
2 40" dia Discharge Pipes Machine V-7·65 ft/sec
Area Pipe 10·5 sq ft V-9·43 ft/sec
OUTLET
8'-6" dia Bellmouth V-2·815 ft/sec
Area per Machine 136 sq ft V-0·984 ft/sec
ELEVATION ABOVE O.D.
"THE ENGINEER"

FIG. 5—CIRCULATING WATER SYSTEM

The abutment was constructed with practically no difficulty as the land between the excavation and the river acted as a dam which kept the water infiltration down to a minimum.

As the river is subject to a 24ft. flood rise and as the railway lines at the south of the site are considerably higher than the land which constitutes the actual station site, it was necessary to elevate the ground floor of the station to avoid flood troubles

istics of the river have changed. Having regard to these circumstances and the fact that no flood has occurred within 3ft. or 4ft. of the 1795 level for 135 years, it was deemed to be reasonably safe to build the station on the assumption that the river was not likely to exceed a level of 142 O.D., for the additional cost of constructing the floor levels and bridge approach at 144 O.D. would have been between £30,000 and £40,000. As the natural level of parts of

site and the railway a very large mound had to be excavated for levelling the ground for the coal store, the building of the embankments and roads would have presented considerable difficulties, but as it was, the spoil from the mound made the job relatively easy.

Geologically, the site is of considerable interest, for it is supposed that glaciers from Scotland and Cumberland were bifurcated by the Wrekin, a large hill to the north of the site, and that they met again on the ground now belonging to the Authority. On the gradual passing of the Ice Age these glaciers are believed to have deposited their detritus on the

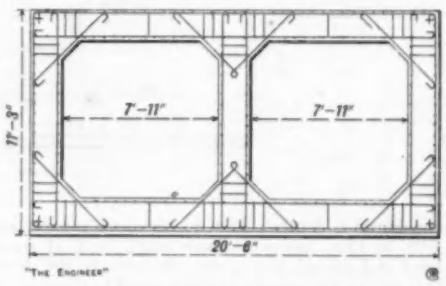


FIG. 6—CIRCULATING WATER CULVERT

site, thus forming the mound mentioned, which, as a matter of fact, was found to contain thousands of fossils and a good deal of Scotch and Cumberland granite in small boulders. The railway station on the site is Buildwas Junction, which forms the point where branch railways from Wellington, in the north, and Craven Arms, in the south, join the Severn Valley railway passing from the main line of the G.W.R. at Shrewsbury along the Severn Valley towards Worcester. From Shrewsbury and Wellington the G.W.R. provides connections to the North and South Wales coalfields, to the Shropshire coalfields within a few miles of the power station, and to the more extensive coalfields in the Cannock and North Staffordshire districts.

The highest point on the site was 160 O.D., on the strip of land that has now been levelled and utilised for the coal store, whilst the lowest point is 124 O.D. and is near the river. A stream which originally crossed the whole site at a point midway between the power station and the circulating water pump-house had to be entirely diverted to the west of the latter. Before any definite foundation work could be proceeded with, it was necessary

to know the nature of the subsoil on which the foundations would be built, and bore-holes were therefore sunk. Generally speaking, the strata of the site was found to consist of top soil, brown marl, or brown clay, sandy clay, and yellow clay in two or three bore-holes, and over the whole site blue clay and blue-grey shale, which penetrated to a considerable depth. At a depth varying from about 10ft. to 15ft., however, there was a level of running sand and gravel, and it was necessary to get through this before a sound foundation could be obtained, this being the only strata which gave any trouble. Bore-holes were also sunk to give some idea of the ground water, and during the testing operations it was definitely proved that 75 per cent. of the inflowing water came from the higher ground and not from the river side of the site, as had been expected.

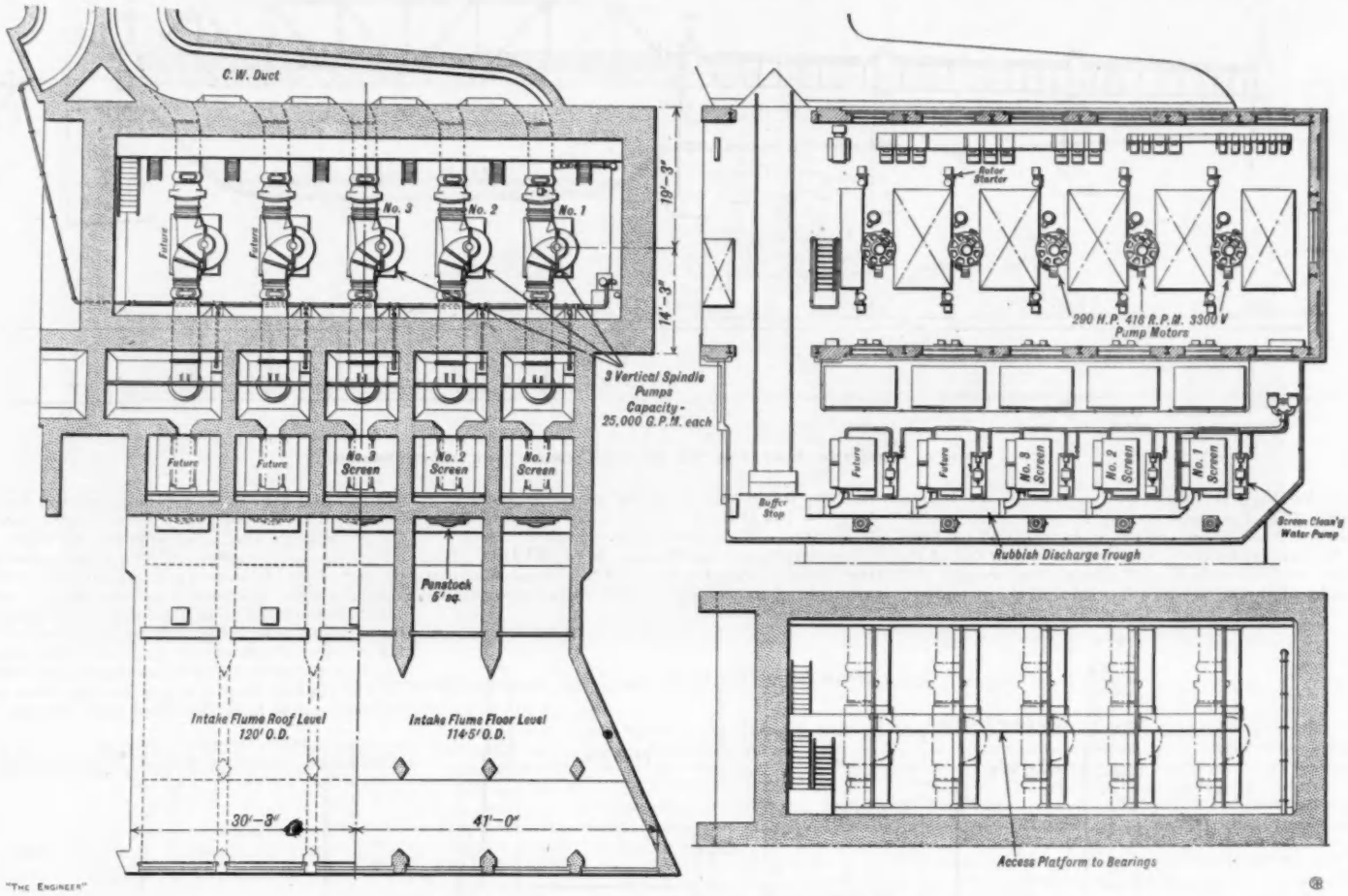


FIG. 7—PLANS OF CIRCULATING WATER PUMP HOUSE

CIRCULATING WATER SYSTEM.

As we have said in the design of the circulating water system an endeavour was made to obtain the most economical syphonic effect. Calculations were made of the approximate cost of foundation work at different points below a certain level and the saving on pumping costs by decreasing the head of the pumps was computed. A position was finally fixed for the turbine house basement, where the saving on pumping rather more than balanced the capital charges on foundation work. The level fixed for the top of the concrete for the turbine house was 135ft. 6in. O.D., the condenser pit being, of course, lower, and this gave a 25ft. dimension for the highest point in the circulating water system below the lowest summer level of 118 O.D. Technical details of the syphonic lay-out, which has been designed with a view of obtaining not less than 60 per cent. syphonic assistance, are given in Fig. 5. The velocity of the water before entering the condensers and the friction head have been kept as small as possible consistent with the cost of civil engineering work on culverts, &c., whilst the velocity of the water discharged from the condensers has been made as high as 9½ft. per second in order that the water may carry away any air that has a tendency to settle out at the high point of the syphon. As at the pump-house end of the system the intake is well drowned, air cannot be taken into the pumps as the result of turbulence at the intake, and at the discharge matters are arranged so that there is a minimum amount of turbulence, the method adopted for obtaining this result corresponding to the draught tube system that is adopted on hydro-electric schemes.

Owing to the diverse conditions under which it has to work, the design of the reinforced concrete culvert itself—Fig. 6—presented interesting problems. With both culverts full and with varying external earth or flood pressure, the worst load was found to be that due to the head pressure of the pumps, and the culvert was designed to meet this condition, the pressure per square foot on all the walls being 2590 lb. per square foot. Shrinkage stresses have been taken care of by providing 0·3 per cent. longitudinal steel. When casting the ducts a joint approximately 18in. wide with the reinforcement continuous across it was left every 30ft., and after the concrete had thoroughly matured these joints were filled in, the reason for this procedure being to enable the concrete to contract in sections of 30ft. before being made into a continuous duct. When filled with water at full pressure no evidence of leakage was found.

PUMP HOUSE.

General arrangement plans of the pump house are given in Fig. 7, which shows the intake flume and the

FIG. 8—MOTORS AND SWITCHGEAR IN CIRCULATING WATER PUMP HOUSE

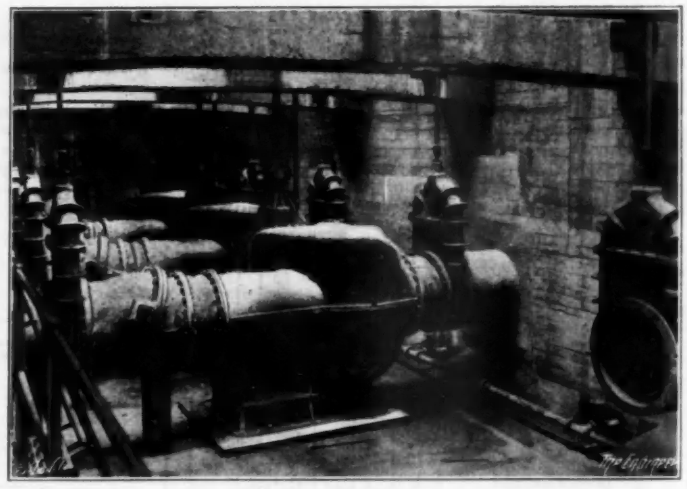


FIG. 9—CIRCULATING WATER PUMP HOUSE BASEMENT

junction with the reinforced concrete ducts for the five pumps for the first two 50,000-kW generating sets, the flume having been designed to reduce the velocity of the water from the river over the outer sill to 1ft. per second, and to prevent bank erosion being carried into the intake under flood conditions the flume is roofed. Owing to the fact that the soil on which the pump house was built consisted of clay and shale, it was possible to carry out the main excavation for the pump house proper behind the protection afforded by natural earth bank between the pump house and the river, but before the flume and outer chambers could be formed a steel sheet pile cofferdam had to be provided. As the water enters the pump section chambers through penstocks, any intake to

the pump suctions can be isolated for cleaning purposes. The Brackett screens, to be seen in Fig. 13 on page 184, are of the latest type, in which the water enters at the sides of the endless band and the screens are so arranged that the *débris* is carried to the top of the band, where it is washed off by means of jets. The design gives twice the area provided by the usual construction and decreases the velocity of the water through the screen openings. As we have indicated, the existing pump house will serve for the first two 50,000-kW sets, but when the capacity of the station reaches 200,000 kW it will be extended to twice its present size. Each of the three Drysdale circulating pumps that have been installed for the existing 50,000-kW set has a capacity of 25,000 gallons of water per minute under a pressure of 28ft. head. Views of the pump house are given in Figs. 8 and 9.

STATION BUILDINGS.

A section through the complete station with the exception of the switch house is given in our Supplement, which also shows the coal-handling plant. The skeleton of the turbine room consists of a steel framework composed mainly of portal bents of a particularly neat type. No lattice bracing is employed in the main stanchions, the bending moments and shears due to wind, the crane, &c., being taken up in gussets, plates, and diaphragms. The crane gantry accommodates a 130-ton crane made by Sir William Arrol and Co., Ltd., whilst in the auxiliary bay there is a 15-ton crane for the workshop, feed heating plant and other auxiliary plant situated in this bay. The boiler-house is a fine building with plenty of light. Its framework is composed of main frames designed on the lines of those used in skyscraper construction, the bending moments due to wind, &c., being taken up in the joints where the main floor members are connected to the main stanchions and the cross bracing met with in many boiler-houses is eliminated. Four stanchions take care of the up and down forces due to wind pressure on the chimneys, the shear being taken up in the cross girders and ties. To provide for uplift caused by the moments of chimneys, &c., massive foundations are provided going down to the shale and below a bad patch of sandy gravel and water.

The switch house and office block is a simple steel-framed building treated on the outside, like the other parts of the station, with dark multi-coloured wire-cut bricks and artificial stone dressings, whilst on the inside common stocks are used which have been plastered where required. The structure is supported on a continuous footing suitably reinforced to take the bending moment developed, and the ground floor is elevated. On the ground floor there are stores and a workshop, whilst the first floor is devoted to offices. Rheostat and battery rooms are on the second floor, and the control room, which houses the whole of the station control gear and that required for the grid sub-station, is above. All the main switchgear is on the ground floor, the auxiliary switches being placed on an adjacent mezzanine floor. Between the switch and turbine houses there is a transformer raft, as shown in the Supplement, for accommodating the transformers for stepping up the generator pressure to 33,000 volts.

COAL-HANDLING PLANT.

The coal trucks from the railway are shunted into the private siding at the east end of the site, where they are taken over by the Authority's locomotive, which draws them over a reinforced gantry, and they are then tipped by a Mitchell patented side-discharge tippler. The wagons vary from 8 to 20 tons capacity and a full train of them can be tipped in the course of an hour. After all the coal has been discharged the train of empty wagons proceeds to another siding at the west end of the site, where they are ready for handing over again to the railway, and a complete circuit is thus provided for the incoming and outgoing coal traffic. The wagons are weighed on the tippler both before and after they have been discharged, and the net weight of coal is shown on a dial and on a ticket printed and issued by an Avery weighing machine. From the tippler the coal is discharged into a 35-ton receiving hopper with a circular plate feeder below it, which delivers the coal at the rate of 160 tons per hour and feeds the store or boiler-house bunkers by means of band conveyors of similar capacity. On the way to the store ground the coal is taken from the feeder along a rubber band conveyor running alongside the full length of the store.

From this conveyor it is fed to a similar conveyor on a travelling gantry or transporter spanning the store, and from this gantry it is discharged at any desired point. As the transporter has a span of 230ft. and runs the full length of the store ground the coal can be discharged or reclaimed at any position on the store heap. For reclaiming the coal from the store bucket dredgers are mounted on trolleys running along the transporter, and they deliver the coal to the conveyor on the transporter, both of the conveyors being reversible. From the store the coal is returned to the feeder mentioned and from this point it begins its journey to the boiler-house by way of a drum separator, which automatically removes tramp iron. From the separator the coal is conveyed by an inclined conveyor to a tower, to be seen in Fig. 1, where the direction of the feed is changed and by means of two other inclined conveyors it is delivered on to the conveyor above the bunkers, from which it is discharged to the storage bunkers at any desired point. At present the external store can accommodate about 40,000 tons of coal, but when the station is extended its area will be increased to allow of storing 70,000 tons. The overhead gantry and the conveyors at the side of the store have been designed with a view to meeting future requirements and to give delivery to either No. 1 or No. 2 boiler-houses either from the railway or from the store. All the equipment is operated with electric motors with interlocked controls, which ensure easy working. The equipment was supplied by the Mitchell Conveyor and Transporter Company, Ltd.

(To be continued.)

The Economics of Urban Electric Railways.

By HENRY WATSON.

No. V.*

NEW TUBE RAILWAYS.

THE previous article dealt with the operating costs of and the traffic required to justify a new electric surface railway, to be constructed in open country adjacent to a large city. We may now attempt to evaluate corresponding quantities for the very costly underground railways so often demanded in London and in other great cities.

Type and Cost of Railway.—The railway considered will be of the deep-level tube type, as constructed in London, with frequent stations equipped with escalators. Favourable geological conditions for its construction are assumed. This being so, the cost of construction on the best authority may be put at £600,000 per mile of route, exclusive of trains and sub-stations. It may easily be more where treacherous subsoils must be pierced, where full-sized trains must be accommodated, or where some heavy engineering is involved in effecting junctions, &c. Indeed, in many cities a figure of £1,000,000 per mile is commonly quoted by competent authorities, more especially in regard to shallow systems constructed in congested business districts; 10 miles of route is assumed, and the spacing between stations is set at ½ mile. This is a typical value for heavily developed urban areas, though rather too close for outer suburban lines.

Service Proposed.—A service of trains equal to one every 3 minutes during rush hours and one every 5 minutes thereafter is allowed initially in Tables XIII. and XIV., though this is open to improvement as an ultimate value. Other services are estimated for separately in Table XVI. The rush period extends over six hours, the slack one over twelve hours. Eight-coach saloon type trains, seating 350 passengers, are run in the former period and are halved thereafter.

TABLE XIII.—*Estimate of Cost of Operating a Tube Railway. Assumptions.*

Length of route—double track	10 miles
Service: 6 rush hours—3-minute, 8-coach,	350-seat trains
12 slack hours—5-minute, 4-coach,	175-seat trains
Average distance between stations	0·625 miles
Average speed, excluding lay-overs	19 m.p.h.
Average speed, including lay-overs	16·6 m.p.h.
Lay-over at each terminal	4 minutes
Round trip time with lay-overs	72 minutes
Trains in service, rush hours	24
Trains in service, slack hours	14
Trains in stock (8-coach)	28
Spare stock over rush hour requirements	17 per cent.
Train-miles per weekday = 10 [(6 × 40) + (12 × 24)]	5280
Train-miles per Sunday = 10 (16 × 24)	3840
Train-miles per year = (5280 × 313) + (3840 × 52), million	1·85
Train-miles per train (8-coach) in stock per year	66,200
Proportion of total mileage run with eight coaches	40·5 per cent.
Average number of coaches per train	5·62
Average number of seats per train	246
Seat miles per weekday	1·34 millions
Seat miles per year	456 millions
Weight of 8-coach train	210 tons
Weight of average train	148 tons
Current consumption at sub-station, direct current	120 watt-hours per ton-mile
Current consumption at sub-station, direct current, average	17·8 units per train-mile
Cost of construction, excluding rolling stock or sub-stations	£600,000 per mile of route
Cost of 8-coach trains	£26,000 each
Cost of all trains	£728,000 lot
Total cost of railway, excluding sub-stations	£6,728,000
Cost of current at sub-station, D.C.	0·7d. per unit
Load factor	38 per cent.

TABLE XIV.—*Estimate of Cost of Operating a Tube Railway.*

Item No.		Pence per train-mile.	Pounds per mile per year.	Route expenses.	Train expenses.
1	Traffic: Wages on trains	3·5	2,700	—	2,700
2	Wages at stations	5·0	3,860	3,860	—
3	Other traffic expenses	2·0	1,540	—	1,540
4	Power	12·5	9,660	—	9,660
5	Maintenance: Trains	6·0	4,630	—	4,630
6	Way and structures	4·0	3,090	2,470	620
7	Station and workshop expenses	5·5	4,250	4,250	—
8	General expenses and rates	6·0	4,630	4,630	—
9	Working expenses	44·5	34,360	15,210	19,150
10	Interest and depreciation, construction	46·5	36,000	36,000	—
11	Interest and depreciation, trains	6·5	5,020	—	5,020
12	Total operating expenses	97·5	£75,380	£51,210	£24,170

Total annual cost of whole system = £753,800.

TABLE XV.—*Details of Estimates of Cost of Operating a Tube Railway.—Cost per Train-mile or per Mile of Route per Year.*

Item No.	
1	Two men at £4 per week of 40 effective hours at 16·5 m.p.h. = 2·9d., or, say, 3·5d.
2	Seventeen stations at £40 per week each = £35,360 per year = 4·6d., or, say, 5d.
3	Includes cleaning trains
4	17·8 units at 0·7d. = 12·5d.
5	6d. = £46,300, or £1650 per eight-coach set or £206 per coach in stock
6	4d. = £30,860, or £3086 per mile of route per year
7	5·5d. = £42,500, or £2500 per station, including running escalators
8	6d. = £46,300, or 6 per cent. of total revenue
9	Excludes interest and depreciation (or complete renewals)
10	5 per cent. interest and 1 per cent. sinking fund on £6 million = £360,000 = 46·5d.
11	5 per cent. interest and 1·5 per cent. sinking fund on £728,000 = £47,320 = 6·2d., say, 6·5d.

TABLE XVI.—*Alternative Estimates of Operating Cost of Tube Railways.*

	A.	B.	C.	D.
Rush-hour interval, min.	3	1½	3	1½
Slack-hour interval, min.	5	2½	3	1½
Train-miles per mile of route year, mill.	0·185	0·370	0·250	0·501
Average interval over 18-hour day	4·26	2·14	3·15	1·58
Seats per rush hour, each way	7,000	14,000	7,000	14,000
Traffic:	Pence per train mile.			
Wages on trains	3·5	3·5	3·5	3·5
Wages at stations	5·0	3·0	4·0	2·5
Other traffic expenses	2·0	2·0	2·0	2·0
Power	12·5	12·5	11·5	11·5
Maintenance: Trains	6·0	6·0	5·5	5·5
Way and structures	4·0	2·5	3·5	2·0
Station and workshop expenses	5·5	3·0	4·5	2·5
General expenses and rates	6·0	3·5	4·5	2·5
Working expenses	44·5	36·0	39·0	32·0
Int. and depreciation: Construction	46·5	24·0	35·0	18·0
Trains	6·5	6·5	5·0	5·0
Total operating expenses	97·5	66·5	79·0	55·0
Annual revenue required, per mile	£75,400	£103,000	£82,400	£115,000
Revenue required per seat-mile	0·395d.	0·272d.	0·345d.	0·242d.
Average passenger flow required at 0·8d. per passenger per mile	1,900	2,600	2,075	2,900
Maximum passenger flow at four times average	7,600	10,400	8,300	11,600
Percentage of seats occupied in maximum hour	108	75	119	83
Passengers required per mile per year at 4d. each, millions	4·52	6·18	4·94	6·93
Proportion of seat-miles to be sold	49%	34%	43%	30%
Seat miles provided, millions	456	911	570	1,140

NOTE.—Estimate C allows 2·5 million train-miles per year.

A speed of 19 m.p.h., with intermediate stops, is possible with high-powered, modern trains, notwithstanding the frequency of stops. With a 4-minute layover at each terminal, the speed falls to 16·6 m.p.h., and this gives a round trip time of 72 minutes.

Stock Required.—To maintain a 3-minute service in rush hours, with a 72-minute round trip time, will require twenty-four trains in service. With 17 per cent. spares, twenty-eight will be kept in stock, these being eight-coach units. The annual mileage per eight-coach set in stock works out at 66,200.

Other Values Used.—Current is considered to be purchased as D.C. at the sub-station bus-bars for 0·7d. per unit, the load factor being 38 per cent. It may be noted in passing that the London County Council tramways delivered 173 million units from their sub-stations, spread over the County of London, in 1929–30, for an all-in cost of 0·687d. per unit. The London Underground power station delivered 300 million D.C. units for ½d. per unit, excluding financial charges. A consumption of 120 watt-hours per ton-mile at the sub-station will be required for this fast service, giving 17·8 units per train-mile, the average weight being 148 tons. Eight-coach trains may weigh 210 tons. Interest is at 5 per cent., it being assumed that a Government guarantee is available, and it is considered necessary for sound financing to amortise the entire cost of construction in 37/40 years, with a 1 per cent. contribution to a cumulative sinking fund invested at 5 per cent. In particular cases lower rates and less conservative policies may prevail, but such are not sufficient for generalising. Rolling stock is depreciated in twenty-one years with a 2·8 per cent. contribution. Station expenses are heavy, because escalators, essential to

* No. IV. appeared Aug. 12th.

attract traffic having modern road facilities, must be operated. Various expenses may be reduced under favourable conditions, but the effect on our conclusions will be slight, owing to the profound influence of financial charges. The details may be compared with Table XVII., analysing the accounts of the Central London Railway for 1931.

TABLE XVII.—*Analysis of Central London Railway Company's Accounts for* 1931.

Item of expenditure, &c.	Aggregate spent in year, £ thous'ds.	Per vehicle or mile of route, £	Per train-mile, d.	Vehicles or miles maintained.
Traffic receipts, after operation of common fund	501	71,600	60·5	7
Maintenance of way and works	46·5	6,640	5·62	7
Maintenance of rolling stock	43·2	166	5·23	259
Maintenance of lifts and escalators	12·0	1,720	1·45	7
Electric train working	111·7	—	13·50	—
Lifts and escalator working	21·5	3,080	2·60	7
Traffic expenses	59·0	8,500	7·13	7
General expenses, rates, &c.	44·8	6,400	5·42	7
Credit for mileage run	Cr. 10·3	Cr. 1470	Cr. 1·24	—
Total expenditure	328	47,000	40·9	7
Details :				
Repairs, permanent way	12·1	1,730	1·46	7
Repairs, electric track equipment	1·74	250	0·21	7
Repairs, motor coaches	26·5	302	3·2	88
Repairs, trailer coaches	15·0	88	1·8	171
Current as D.C.	57·0	—	6·9	—
Wages of trainmen	44·5	—	5·4	—
Car cleaning and depôt expenses	16·5	—	2·0	—
Running and maintaining lifts and escalators	33·5	4,790	—	7

Train-miles run in relation to receipts or whole expenditure, 1·988 million; by company's trains, 2·475 million. Route miles owned, 7 (underground); running powers (surface), 4. Unit values derived with former quantities in all cases. Number of stations owned, 15; number of lifts, 31; number of escalators, 6. Passengers carried, 44·2 million = 6·3 per mile. Receipts per passenger, 2·72d.; capital expenditure on line, £4,659,000 = £666,000 per mile. Car-miles per train mile = 4·18.

Working Expenses.—With the somewhat limited service assumed in Table XIV., we obtain working expenses before providing for interest and depreciation (otherwise amortisation or complete renewals) of 44½d. per train-mile. With double the service the cost falls to 36d., as in estimate B, Table XVI., the incidence of such fixed route expenses as wages at stations, maintenance of way and structures (say, 50 per cent. of) station and workshop expenses, general expenses, and rates, on the cost per train-mile being very nearly halved.

Financial Charges.—With a 3/5-minute service the financial charges are more than the entire working expenses. The effect of increased service in reducing the cost per train-mile, and the rate of fare necessary is therefore most pronounced. With double the service the financial costs fall from 46·5d. to 24d., excluding the cost of providing and renewing trains, which remains constant at 6·5d. per train mile.

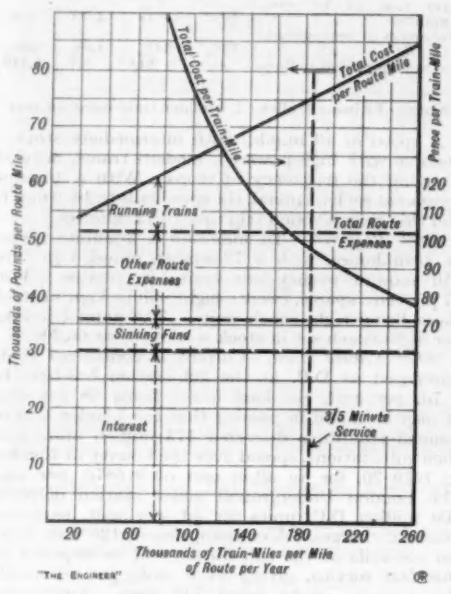


FIG. 7

Total Expenses.—This service requires a total revenue of 97·5d. per train-mile, or £75,400 per route-mile per year. Double the service costs £103,000 per mile per year, or only 37 per cent. more. The average revenue on the London Underground Railways is of the order of 70d. per train mile, and the cost is not brought down to this level until the revenue attains nearly £90,000 per mile—see Fig. 7. If we may take a higher value of cost per train-mile, for present-day construction, we may assert that the minimum revenue for a new tube railway must be some £75,000 per mile annually. Less than this will force the cost per train-mile over 100d., and imply a high rate of fare and inadequate service. It is to be noted that the average net revenue of the London tubes is of the order of £70,000 per mile, that most of these were constructed pre-war, when civil engineering was much less costly than to-day, and that the average dividend rate is only about 5 per cent. Our estimates and Fig. 7 show that the fixed or route expenses, in providing, maintaining, and staffing the railway, amount to no less than some £50,000 per mile. Of this, £36,000 is in respect of financial charges on the construction cost. At this frequency over 50 per cent. of the entire operating costs is absorbed in financial charges. Clearly, a less frequent service would not be worth while. A revenue of £60,000 per mile, for example, would provide only a 6/10-minute service, which would be quite inadequate for a tube system.

Passenger Flow.—A revenue of £75,400 will require an average passenger flow in one direction for eighteen hours at an average rate of fare of 0·8d. per mile, of 1900 per hour. The maximum flow may be four times the average, so that 7600 passengers may move in the busy direction in the busiest hour.

Average Fare.—The average rate of fare on the London Underground system is 0·8d. per mile. Less than this can hardly be sufficient for transport by costly underground railways, except on routes of the greatest activity, whilst a higher rate may cause serious loss of traffic to surface facilities. An average ride of 3 miles in central areas, or 5 miles on suburban routes, will be typical, and these entail average fares of 2½d. and 4d.

Total Passengers Needed.—Assuming an average fare of 2½d., our 10-mile tube requires 72 million passengers per year to provide the total revenue of £754,000 needed, or 7·2 million passengers per mile. This is an appropriate figure where only comparatively short journeys are involved, as in Central London. But with the longer journeys more commonly found on suburban lines the average fare might be 4d., in which case the total traffic must be 45 million passengers per year, or 4·5 million per mile.

Taking the latter figure for long-distance journeys, with stations every ½ mile, 2·8 million passengers must book at each station annually and yield a revenue of £47,000 each.

Revenue Per Mile Required.—A more reliable and more consistent indication of traffic requirements is afforded by reference to revenue per mile. This may be put at not less than £70,000 per mile—without heavy subsidy—whilst a revenue of over £90,000 must be extremely difficult to secure, this value being exceeded on only a few very intensely operated services.

Smallest Practicable Tube Scheme.—In general a tube railway less than 4 miles long is unlikely to be a sound proposition. Otherwise the average journey length will be too short to permit it to compete with road transport. Moreover, the majority of the traffic thereon must travel from terminal to terminal, and this implies that there must be populous centres at each end and not merely between. Deep-level railways are not likely to attract passengers travelling less than 3 miles, if road services are speedy and adequate, for there must be an appreciable and definite time saving before optional travellers will trouble to book and descend to deep-level platforms. Such a railway must therefore terminate with one end in the city centre. A 4-mile line, crossing the city business area and connecting points equally distant from the centre, would be of little value, as the average journey length would be too short for the railway to be effective. This observation does not include short extensions to tube or surface railways, terminating some distance from the destination of their passengers, or where there is a heavy potential, through rail traffic across the city from one line to another. But as separate entities underground railways should reach out at least 4 miles from the city centre to yield definite advantages.

Putting the revenue per mile at £80,000, we shall require a total revenue of £320,000 per year. That is, we have to find a third of a million pounds annually to pay for this 4-mile tube. Probably 80 per cent. of this must come from terminal to terminal traffic, or, say, £260,000.

An average ride of 3½ miles and an average fare of, say, 3d. (giving an average rate of 0·86d.) can hardly be exceeded. We require 25·6 million passengers, or 2·56 million per mile. If the population centred about the suburban terminal is essentially dependent on the railway, as many as 150 rides per head per year may be attained. As there are 20·8 million rides between terminal to terminal, a total population of 140,000 must be centred around the suburban terminal. But for so large an area 120 rides per head might be a safer value to allow, particularly if adequate and economical road services exist, and this demands a population of 175,000. We may draw the conclusion that a 4-mile tube must serve a population of some 150,000 to 180,000, wholly and effectively, the majority of it being close to or using the suburban terminal station, unless it is subsidised.

Effect of Heavy Traffic.—As explained before, heavy traffic permits cheaper fares by reducing the cost per train-mile, and by permitting better loading of mid-day trains running at given intervals. Since two-thirds of the total operating costs of a tube are in respect of fixed or route expenses, it is most desirable to concentrate all possible traffic on to it to reduce the cost per passenger. Observe the following comparisons of cost and rates of fare, the first column utilising figures derived as above :—

	A.	B.	C.	D.
Service intensity	Low	High	Very high	Medium
Average passenger flow	1,900	3,800	3,800	1,900
Maximum passenger flow (4 : 1)	7,600	15,200	15,200	7,600
Rush-hour interval, min.	3	1½	1½	3
Slack-hour interval, min.	5	2½	1½	3
Revenue per mile per year	£75,400	£103,000	£115,000	£82,400
Seats per hour provided	7,000	14,000	14,000	7,000
Average rate of fare, per mile	0·8d.	0·55d.	0·61d.	0·88d.

With double the traffic, as in B, the fare rate can be lowered from 0·8d. to 0·55d. For 10 per cent. extra cost, in both cases, the rush hour interval can be maintained throughout the day. The service in case C is extremely intense and rarely, if ever, provided in practice. In A and B 50 per cent. of the seat miles run must be sold. On the average nearly 10 per cent. of the rush hour passengers must stand. At times, however, the proportion will be much more than this, owing to short-period fluctuations in the busiest hour and to imperfect grading of the flow of seats per hour in relation to the flow of passengers along the route. But saloon coaches, seating only forty-four passengers each, can accommodate 100 per cent. standing without difficulty. The services and rates of fare shown are therefore fairly adequate.

Further consideration of tube railway requirements and statistics of service characteristics will be given in the next article.

(To be continued.)

Rail and Road Transport.

On April 11th last the Minister of Transport remitted to a Committee or Conference the following terms of reference :—

> From the point of view of establishing what would be a fair basis of competition and division of function between rail and road transport of *goods*, and for the purpose of furnishing advice and information upon which the Minister of Transport will *invite the views of the Highway Authorities and other interests concerned*, to consider the facts relating to the incidence of highway costs in relation to the contributions of the different classes of mechanically propelled vehicles; to consider the nature and extent of the regulation which, in view of modern economic developments, should be applied to goods transport by road and by rail; and, in the light of any conclusions reached under these heads, to make such further recommendations as they are able to frame designed to assist the two sides of the industry to carry out their functions under equitable conditions, which adequately safeguard the interests of trade and industry; and to report by the end of July.

The Committee was composed of the following members :

Chairman :

Sir Arthur Salter, K.C.B.

Representative of Railways :

Sir Herbert A. Walker, K.C.B., Chairman, General Managers' Committee, Railway Companies' Association; General Manager, Southern Railway.

Sir Josiah Stamp, G.B.E., Chairman, London, Midland and Scottish Railway.

Sir Ralph Wedgwood, C.B., C.M.G., Chief General Manager, London and North-Eastern Railway.

Sir James Milne, C.S.I., General Manager, Great Western Railway.

Representative of Goods Transport by Road :

Mr. C. le M. Gosselin, M.I.A.E., Past-president, Commercial Motor Users Association (Inc.).

* Mr. P. R. Turner, Vice-president, National Road Transport Employers' Federation (Inc.).

Mr. W. H. Gaunt, O.B.E., Distribution Manager, Messrs. J. Lyons and Co., Ltd.

Mr. E. Graham Guest, J.P., M.A., B.Sc., President, Scottish Commercial Motor Users Association (Inc.).

Joint Secretaries :

Mr. G. Cole Deacon, Secretary, Railway Company's Association.

Mr. F. G. Bristow, C.B.E., F.C.I.S., General Secretary, Commercial Motor Users Association (Inc.).

The Report of the Conference was submitted to the Minister of Transport a few days ago and issued to the public on Wednesday last. It is rather long and is accompanied by several appendices, but the following extracts touch upon the principal considerations and recommendations. We may premise them with the important remark that the Conference was concerned, not with transport generally, but with goods transport alone.

PART I.

Introductory.

The questions we have been asked to consider fall into three principal categories :

(*a*) The incidence of highway costs in relation to the contributions of the different classes of mechanically propelled vehicles.

(*b*) The nature and extent of the regulations which, in view of modern economic developments, should be

* Note.—Mr. Turner attended Meetings of the Conference up to the 10th June. Serious illness prevented him from attending further Meetings, and for the rest of the Conference his place was taken by Mr. W. Edwards, President, National Road Transport Employers Federation (Inc.).

applied to goods transport by road and rail.

(c) In general, any measures which may assist the two sides of the industry to carry out their functions under equitable conditions, which adequately safeguard the interests of trade and industry.

As regards the whole of this work our object has been the ultimate establishment of a "fair basis of competition" such as will tend to secure a better "division of function" between goods transport by rail and road respectively.

The problem of unfair competition between road and rail did not arise before the advent of the internal combustion engine, because the railways and the canals had a natural advantage over any form of transport for the class of traffic for which they were suitable, which no free use of the roads by horse-drawn traffic could substantially impair. In a single generation this situation has been completely transformed. The roads are now predominantly used by motor vehicles; all other use made of the roads, though not unimportant, is entirely secondary.

But while the new facilities have resulted in additional transport and travel, they have also diverted much existing traffic from the railways. In some cases this is because the road is intrinsically more suitable; is preferred for the convenience it affords, or is really cheaper when every allowance for full cost is made. But it is also obvious that, if and so far as the new commercial means of transport on the roads do not pay their fair share of the cost of the roads, corresponding to the charges which fall upon the railways in respect of their permanent way, or are unfairly free of any restrictive regulations analogous to those under which the railways operate and serve the trader, some of this diversion may be both economically unsound and socially undesirable. A fair basis of competition is therefore necessary, not only in the legitimate interests of the railways and also of trade and industry as a whole, but in order to help in securing a proper division of function which is in the general public interest.

It is essential that this problem should be fairly stated and conceived from the outset. In its general character it is well recognised, and no elaborate preface is needed; but exaggerations have been frequent.

The railways, of course, constructed their own permanent ways out of loan capital which constitutes about one-third of their liabilities, and by means of share capital, the dividends on which have disappeared or have been so materially reduced. They bear the full cost of their maintenance. The railway representatives furnished the following figures in illustration of this point:—

Railway Track Costs Corresponding to those Provided by Public Authorities for Road Users for 1930.

	£ (millions).
Interest on capital:	
£800,000,000 at 4½ per cent.	36
Maintenance and renewal:	
£18,000,000	18
Signalmen:	
£6,500,000	6½
Rates:	
£3,500,000	3½
Total	64

The large sums which have to be paid by the railways in respect of the interest on the capital required to construct their permanent way constitutes a principal difference between their situation and that of the road transport industry.

Road transport, on the other hand, utilises as its permanent way the general road system, which has been constructed and transformed, and is maintained, by public revenues.

Such a statement would, however, by itself be misleading and unjust. Road users, in addition to being like those who are interested in railways, both taxpayers and to some extent (though small in comparison with the railways) ratepayers, pay special taxes in the form of both licence duties and petrol duty, the receipts from which, if we aggregate them for all classes of motor users, are equal to current expenditure on the roads. Commercial road transport by itself is far from paying this total cost, but, on the other hand, it would obviously be unjust that it should, for it is not at all in the same position as if it had constructed at its own cost a road system designed and reserved for its exclusive use.

It is, however, unreasonable to argue that if contributions and taxation from all sources connected with motoring covers the costs of the road, a fair basis of contribution is necessarily secured. For if a certain class of users, such as those who own private cars, pay more than their proportionate share, it may be just either that the charges upon them should be diminished, or, if Parliament considers them a proper subject of what may be called sumptuary taxation, on the assumption that the possession of a motor car is a presumptive indication of "ability to pay," that the surplus should go in aid of the general State revenues. But there is no reason whatever why such a surplus should operate as a relief to the appropriate burden of charges upon the commercial motor users who are in competition with other forms of transport which must be fairly assessed and imposed if the basis of competition is to be equitable and the resultant division of function economically sound.

Our task has been to determine what is this appropriate contribution. As we indicate later, we consider that the relative contributions need correction, and that, especially for certain classes of commercial goods vehicles, they need to be increased. There are, however, certain fundamental issues which call for clearer recognition than they have received hitherto by the general community.

It must in fairness be admitted that the present situation of the railways is in part due to the fact that for many classes of traffic the motor vehicle is both more convenient and essentially more economical than the railways, which are necessarily confined to their own permanent tracks. The railways' position is also in part due to the general trade depression, and so far as this is so, there is no remedy except that which will come from general recovery. Against these two major causes of loss—the one permanent and the other temporary—the railways must look to their share of a generally increasing total of trade as economic activity expands with population and higher standards of life, and to the new facilities they can themselves offer to the public by co-ordinating railway transport with road transport, whether their own or not; and for the rest must deal with their losses in the appropriate manner.

In our recommendations we can only offer an alleviation of the third of the principal causes of loss, namely, by dealing with any existing unfairness in the incidence of highway costs and inadequacy of the regulations to protect the public and other users of the road against undesirable forms of road traffic by goods vehicles.

It must not be assumed that this will necessarily result in a situation that is of the maximum economic advantage to the community as a whole. This would only be the case on the assumption that we can properly isolate particular industries without regard to the essential solidarity of industry and railway services as a whole and to the interdependence of their fortunes. The correction of the incidence of highway costs may mean that each class of road transport is in future paying its own real economic cost. But the withdrawal from the railways of all classes of traffic which finds road transport economical, even on this corrected basis, may still create a situation on the railways which must react seriously upon other industries. Railway transport caters for all industries; and its tariffs have been built up on the principle of charging less than a proportionate cost of service to certain traffics, and more to others. The limitation of charges in the first case has been possible because the railways were also carrying the other class of traffic. Even when we have corrected the incidence of highway costs, therefore, the broad question remains, whether it is possible to retain in permanent equilibrium two systems, the economic cost of service being the guiding principle of charge for one set of industries, and "what the traffic will bear" for the other.

PART II.

Incidence of Highway Costs.

We are happy to say that we are in full agreement as to the main principles which should govern the determination of the charges upon commercial motor transport.

The railway representatives ask no more than that this transport should pay its fair share of the cost of the roads they use as their permanent way. They do not ask that, either by taxation beyond this point or by restrictive regulation not required in the public interest, traffic should be forced back to the railways which they are not able to carry so conveniently or on so low a basis of real cost. They do not ask that any class of service which may have been rendered obsolete or comparatively uneconomical by the new form of transport now available should be artificially maintained. In other words, they do not ask for any action which would tend to secure a different division of function than would result if a single administration, without divergence of financial interest, were solely occupied in meeting the needs of the public by the most convenient and economical arrangement of transport.

The road representatives, on the other hand, do not ask that commercial road transport should pay less than its fair share of the cost of the roads, or should, by so doing, attain any other development than that which is economic and in the public interest. They accept the principle that when those previously accustomed to use horse transport, without other contribution to the cost of the roads than they made as rate or tax payers, turn to motor transport and so enter into direct competition with the railways, they should in equity pay their full share of the cost, without deduction in respect of the right of untaxed use which they previously enjoyed when employing horses. All they ask is that they should not, as motor users, be taxed more than these principles involve or be restricted in the exercise of their occupation by regulation more than the public interest genuinely requires, and on this demand they are, as stated above, supported by the railway representatives.

We have to recommend what is the total annual sum which is properly to be allotted to mechanically propelled vehicles as a whole and then what is the just incidence as between the different classes. In order to arrive at the first it is necessary, of course, to make allowance for the other uses to which the roads are put by those who make no payment therefor except through rates and taxes—that is, for what is commonly termed the "community use" of the roads.

These "community uses," as a whole, require a substantial allowance. It is clear that if motor traffic had a monopoly of its permanent way as the railways have, it could go faster without danger, and it would be relieved of part of its insurance charges. On the other hand, if there were no motor traffic, the community would need roads and would incur a substantial expense in maintaining them as is shown by a consideration of the expenditure before the motor era and by the general increase of prices and costs since then.

On what principle should allowance be made for this community use? The only fair principle, in our view, is to consider the total annual cost of the roads and then to distribute it according to a just estimate of the use enjoyed, and wear and tear caused, by different categories of users. This is the just principle, but it is obviously very difficult to translate exactly into figures; there is no sufficient exactness in the data to enable the problem to be solved by a mere arithmetical calculation.

We do not think that any allowance should be made, in assessing the sum to be allocated to road users, in respect of indirect benefits from new roads. Not only are they in their nature incapable of close estimation, but they are essentially of the same kind as those which accrued both to the individual and to the community when the railways were built without any subsidy from public funds.

We therefore confine ourselves to the question of allowing for "community uses" of the kind previously stated. Before we attempt a solution of this question, however, we will consider a factor on the other side which is equally incapable of exact arithmetic solution.

Present road users enjoy a very substantial "legacy from the past" in respect both of the road system existing before the motor era and of the heavy capital expenditure on the work of transformation during this era. We have already pointed out that, with few exceptions, the roads now used by motors are the roads originally made for other traffic, improved and adapted, but not constructed on newly acquired land. With the exception of the new arterial roads and by-passes, there is nothing in modern road history comparable to the acquisition of land, and construction of tracks, in the period of railway development which still accounts for the greater proportion of the railways' indebtedness and share capital.

After long discussion of this question and that of "community use" described above, these two factors, each incapable of exact calculation and required on opposite sides of the account, seemed to approximate closely in order of magnitude. It was agreed, therefore, that, on the understanding that annual road expenditure would be calculated as described later in this report (so as to include future expenditure, whether out of revenue or loans, but to exclude any item in respect of the service of past loans), these two items of "community use" on the one hand, and "legacy from the past" on the other, might fairly be regarded as cancelling each other. It follows from this conclusion that we consider that the total contribution payable by all classes of mechanically propelled vehicles, whether in the form of licence duty or petrol duty, should be equal to the *current expenditure on the roads, without net addition or reduction in respect of the above two items.*

Annual Road Expenditure.

We come, therefore, to the assessment of the annual sum to be taken as the current road expenditure. In arriving at this estimate we had in mind the general stage of road development which is described above. After consideration of the accounts of the last five years and allowance for the extent to which that of the last two years has been of an abnormal character, the fairest figure to represent annual expenditure as a basis of a scheme of allocation for the period ahead seems to us to be £61 million, from which we must deduct £3 million in respect of "recoverable expenditure," and to which we must add £2 million to represent the annual expenditure on policing, &c., resulting in a net figure of £60 million.

As we have already allowed for the use of the roads for other purposes, this annual sum of £60 million is that which we consider should be allocated among all classes of mechanically propelled vehicles for the purpose of determining the amount which each class should pay as its contribution towards the total annual road costs. What is the best basis for this allocation?

We have examined three principal systems proposed for the purpose, and we will comment briefly upon each.

(a) *Speed-tons.*—The first of these combined a "speed-ton" factor with the automatic incidence of the petrol duty through petrol consumption. It was proposed to determine the licence duty for each class of vehicle by means of an index obtained by multiplying its tonnage by its normal speed per hour. For this purpose the legal maximum speed, where prescribed, was taken and for private motor cars and cycles, where there is no such maximum, a speed of 35 miles an hour was presumed. We came to the conclusion that this combination of factors did not in itself give a satisfactory solution of our problem. We all agreed that speed is a factor of which some account must be taken, but the precise arithmetical ratio taken in the formula mentioned above is obviously very questionable. In fact, the more reliance was placed upon the speed-ton principle itself, the more anomalous did the consequences tend to become. We agreed, therefore, that while the speed factor must be reflected in any allocation, it must be by a different method.

(b) *Petrol Consumption.*—Another system proposed was one based mainly upon petrol consumption and the petrol duties. It was proposed that some 80 per cent. of the total contribution required should be obtained by means of a shilling duty a gallon on petrol; other factors being allowed for in reduced licence duties calculated on the aggregate to produce the remaining 20 per cent.

There would be great advantages in taking petrol consumption as the main criterion of incidence, as well as the main method of collection, if it would give reasonably equitable results. With regret, however, we came to the conclusion that, while an excellent measure of varying use and wear of the roads by different vehicles of the same general weight and description, it is a defective measure of varying use and wear by different classes of vehicles, and this to an extent that would not be adequately corrected by the reservation of 20 per cent. of the total contribution for collection in the form of graded licence duties representing a general road franchise. This is largely due to the fact that in recent years the skill of the mechanical engineer has succeeded in securing a much greater result in work done in relation to petrol consumption in the case of the heavier vehicles.

It will be a sufficient illustration of this to state that a light van of 24 cwt. laden weight does 18 miles to the gallon, and a heavy lorry of 15 tons laden weight 4½ miles to the gallon, so that in the latter case three times as much weight would be transported (although at a lower speed) over a given distance for the same petrol consumption and, therefore, petrol duty. We consider this is so obviously wrong as a measure of the use and wear of the roads in the two cases that petrol consumption must be rejected as a sole basic criterion of the incidence of highway costs as between different classes, and that it cannot well be adequately corrected by reserving a comparatively small proportion of the contributions for allocation on other factors through the licence duty. At the same time petrol consumption is obviously a useful element in a criterion and, as will be seen, we have employed it in our final proposal. Moreover, it is so valuable in securing a just incidence as between different vehicles of the same weight and description—reflecting, as it does, both distance and speed—that we consider that, when the total contribution to be secured for each class has been otherwise fixed, there is a substantial advantage in collecting this total to as great an extent as at present by petrol duty.

(c) *Ton-miles.*—A third basis which we considered in order to obtain a criterion for the incidence of highway costs is that of the "ton-mileage" of the different classes of vehicles, that is, a criterion which determines the appropriate contribution to be made by each class of mechanical transport by ascertaining on a system of averages the laden tonnage of the vehicles in the class, multiplying this by the estimated mileage they cover in a year, and distributing the total of £60 million according to these results.

We consider that ton-mileage must certainly be an important factor in a just criterion of allocation. Nevertheless, we do not consider that it is in itself sufficient.

Some allowance must, we think, be made for speed, for differences in range and character of road use, and, in certain cases, for wear and tear on the one hand not adequately measured by ton-mileage alone, although, on the other hand, lessened by the use of pneumatic tires and additional axles and wheels.

In order to make an approach to securing an allowance for the above factors, we concluded that a system of allocation based equally on ton-mileage and on petrol consumption would be the most adequate general formula for our purpose, and would take all relevant factors into reasonable account, although still subject to qualification in the case of the heaviest classes of vehicles. We therefore took the mean of the results given by the "petrol consumption" criterion described in (*b*) above, and those given by the "ton-mileage" criterion described in (*c*). The effect of this combined criterion would be to allot £23,847,554 to commercial goods vehicles and £36,152,446 to all other mechanically propelled vehicles.

On a close examination of this combination of ton-mileage and petrol consumption as a measure of the use and wear and tear of the roads, we came to the conclusion that some further correction is required, and that a somewhat greater allowance should be made for speed and unlimited franchise of the road at one end of the scale than for the extra wear and tear caused by the heavier vehicles, of which a considerable proportion, but by no means all, are to be found among the goods vehicles, at the other end of the scale.

In the circumstances we therefore arrived at our final conclusion, in full agreement, that the £60 million should be allocated in the following proportions among mechanically propelled vehicles :—

(1) £23½ million to commercial goods vehicles ;

(2) £36½ million to all other mechanically propelled vehicles (private cars, motor cycles, coaches, omnibuses, taxis, &c.).

Having decided that £23½ million is the annual sum to be borne by mechanically propelled commercial goods vehicles as a whole, we have now to consider how this sum should be distributed among the different classes of these vehicles.

We recognise at once that such a total sum—about £2½ million more than the present yield of licence and petrol duties from commercial goods vehicles—involves considerable increases in the contributions to be made by certain classes of vehicles. This is inevitable if each class is to bear its fair share of road expenditure, and if a basis of fair competition is to be established.

We have already referred to the estimate that some £1½ million of the £60 million may be attributable to the existence of vehicles of a weight of more than 4 tons unladen, which involve a use and wear and tear of the roads out of proportion to their ton-mileage and petrol consumption. Of this sum, when due regard is paid to the legal limitation of speed of the heavier classes, some £500,000 may be regarded as applicable to goods vehicles. This £500,000 is included in the total of £23½ million. Its relevance to our present question is that it suggests that in distributing this sum among goods vehicles, a larger allocation is required for the heavier classes than would follow from the simple application of the ton-mileage-petrol-consumption criterion.

The railway representatives would have preferred the plain criterion of ton-mileage, but were, nevertheless, prepared to depart from it (1) by introducing the criterion of petrol consumption to the extent of half the cost, for the reasons given, and (2) by recognition of the *status quo* in refraining from taking the relief given to the existing contributions of the lower weight classes of vehicles and spreading it over the higher weight classes.

But the road representatives preferred a different method of allocation, and as this produces the same total contribution (viz., £23½ million), although the railway representatives do not identify themselves with all the principles involved in it, they feel that the differences are not sufficiently important to justify practical disagreement, and are prepared to concur in it as an effective recommendation.

Two classes of vehicle still require special mention. First, those which, by using other motive power than that given by petrol, escape the petrol duty. The schedule of new licence duties which we recommend includes in the proposed licence duties for these vehicles the equivalent of what they would otherwise pay in the form of petrol duty. The result is necessarily to show very striking increases as compared with the present duties. But this is only a reflection of the fact that these vehicles are at present enjoying a large concealed subsidy, and is inevitable if they are in future to pay their fair proportionate contribution to road costs.

Further recommend that a vehicle exceeding 4 tons in unladen weight, exclusively employed within an immediate port area (to be defined by the Minister of Transport) should receive a rebate on the normal licence duty of 25 p.c.

Having regard to the foregoing considerations, the Conference unanimously advances and recommends new scales of licence duties for the different classes of commercial goods vehicles.

The proposed licence duty has been worked out for each class of commercial goods vehicles by category and weight so as to give the appropriate total for the class on the assumption that the present petrol duty is continued. The effect of this is that, within each class, individual vehicles pay more or less of the total according to distance actually run to the extent to which petrol duty makes up the total ; as regards the balance, raised by licence duty, the vehicle which does more than the average of its class gains, and the vehicle which does less, loses.

PART III.

Regulation and Licensing.

We now come to the second main division of our task—that of considering "the nature and extent of the regulations which, in view of modern economic development, should be applied to goods transport by road and rail."

The railways are subject to an extensive and often meticulous system of regulation and supervision. This system has grown up in a period in which the railways, while competing with each other where the geographical area of their respective services permitted, enjoyed a large measure of monopoly within their own areas, and as regards the classes of transport for which they are especially fitted. There was nothing in the form of effective competition at all comparable with that of the commercial passenger and goods transport services which are now on the roads. This system of control is of especial importance in regard to rates. As common carriers the railways are under obligation to carry goods at rates which do not discriminate between one person and another ; the rates themselves are subject to control by a tribunal, and must be published. Similarly, the arrangements as to wages and conditions of service are such as to give very effective protection of the interests of the railway employees ; and the ability of the management to make changes is confined within narrow limits and subject to a complex procedure.

It is agreed that the conditions upon which competition should take place ought to be more on an equality. We had therefore to consider whether we should proceed in the direction of asking for greater liberty for the railways, or, on the other hand, of recommending certain public safeguards to be extended to the operation of the motor transport service.

In the matter of rates, where it might seem *prima facia* that the existence of effective competition over the whole area of the railways' work makes the system in force as regards railway rates unnecessary, we do not recommend any fundamental change.

The same is true as regards wages and conditions of service. The system under which the rights of railway employees are protected is the counterpart of the organisation of the railway administration, and no change in the legal position, even if practicable, would be likely to change the position substantially. The less favourable conditions obtaining over a part of the haulage industry are due to the great number of individual units in that industry. But it would not only be impracticable to make the railways free to compete in these respects on equal terms with those particular hauliers who work their men for excessive hours at inadequate wages, it would be in the highest degree socially undesirable. In justice to the employees and also in the interests both of the railways and of those hauliers who are struggling to maintain satisfactory wage rates and conditions of work, it is of the utmost importance that our efforts should be devoted to end the abuses in these respects which have so far attended the organisation of the industry in so many small units.

We consider that some regulation of goods motor vehicles is necessary ; and we believe that it can be enforced only through a licensing system. We agree without hesitation that all such vehicles should be required to have licences which are conditional, not only upon the payment of the appropriate contribution towards the annual road costs, but also upon the observance of proper conditions as to fair wages and conditions of service, and the maintenance of the vehicles in a state of fitness.

We consider that both hauliers and ancillary users should be subject to regulation, enforced through the grant of licences, as regards fair wages and conditions of service and the maintenance of their vehicles in a state of fitness, but that hauliers, with the right to carry the goods of the public, should properly be subject to some measure of regulation not applicable to ancillary users.

We consider that it is desirable that such records should be kept as will help to secure the due observance of the prescribed conditions of maximum weight to be carried and hours of work. For this purpose it is desirable, in all suitable cases, that journey records should be kept in which the weights of commodities loaded, working time and rest periods of drivers, &c., should be inserted.

The railway representatives urged that, having regard to their own obligations as to publicity and control of rates, somewhat analogous obligations should be imposed upon road hauliers. The road representatives urged the extreme difficulty of applying any such system in view of the present organisation of the haulage industry.

All were agreed as to the immediate introduction of the measures of licensing control described above (as regards conditions of service, fitness of vehicle, &c.). The railway representatives would have preferred that the question of publication of rates should have been dealt with forthwith. They agreed, however, to the proposals of the Conference being confined to two following recommendations :—

(*a*) That the Licensing Authority shall have the right of access to information as to the rates charged by an applicant if he considers the information relevant to the discharge of his duties as prescribed in paragraph 111D (i).

(*b*) That the licensing system proposed should be brought into immediate operation and that the Minister should examine the question of publication and control of rates, in consultation with the Central Advisory Committee, with a view to the establishment, if necessary, of a system for the publication and possibly the control of rates.

PART IV.

Division of Function and General.

We now come to the third part of our task, which is to recommend "in general, any measures which may assist the two sides of the industry to carry out their functions under equitable conditions, which adequately safeguard the interests of trade and industry."

To some extent we have covered these questions by our recommendations as to the incidence of highway costs and licensing control. For the fairer basis of contribution which we propose, and the removal of certain abuses through the conditions to be attached to licensing, will tend to a more economically sound division of function between road and rail goods transport, and also to the discharge of these functions under more equitable conditions, since the provisions as to licensing include safeguards for the interests of trade and industry.

We do not consider it practicable to go much further than this in our present report in the direction of determining and prescribing respective functions.

We agree, however, with the Royal Commission on Transport (Final Report, paragraph 267) that it is not "in the national interest to encourage further diversion of heavy goods traffic from the railways to the roads," and we agree in recommending that the Minister of Transport should obtain powers to prohibit by regulation classes of traffic which are borne by rail and which, having regard to the character of the commodity and the distance together, are unsuitable for road haulage, from being transferred in future to the road. We do not propose to examine in detail the different classes of traffic, *e.g.*, what commodities beyond what distances, should be prohibited by the Minister in the exercise of such powers. But we recommend that he should examine the question and take the advice of the Central Advisory Committee, which we have proposed for other purposes.

In addition to such a prohibition of certain classes of traffic, there is, of course, the existing restriction of certain types of vehicles. Moreover, local authorities have powers to secure the exclusion of certain vehicles, elsewhere permitted, from specified roads ; and, as already stated, we contemplate a more extended us of their powers in this respect.

The prohibitions referred to in the two preceding paragraphs would, of course, apply equally to hauliers and ancillary users.

Though, however, prohibitions and exclusions of this kind will doubtless vary as the public interest may seem to require in the light of later experience, we do not contemplate that such negative action will determine division of function except to a relatively limited extent. We conceive that, in the main, transport will divide itself between road and rail as the demand of those who require it, and the facilities offered by those who provide it, determine. The fairer incidence of costs which we recommend will, of course, tend to make the result more economically sound. But we believe that the best division of function will be obtained mainly through the deliberate effort of those engaged in road and rail transport to coordinate their services and give the public the full advantages of complementary service.

This opinion is related to the general conception which underlies the scheme of recommendations in this report, and our general view as to the probable and desirable evolution of transport in this country.

There has hitherto been a competition between road and rail of an embittered character which we hope our proposals will help to end. We conceive that the ultimate form of competition will and should be mainly along a different line. The hauliers on the one hand and the railways on the other are essentially two branches of the nation's common carrier service. More and more we conceive that, while they may still compete with each other, on the fairer basis resulting from our recommendations they will in future be concerned so to organise their services that in collaboration they can attract the public to resort to them for all classes of traffic in which large-scale organisation has great advantages.

For local collection and local delivery, and for conveyance up to a distance which varies with the nature of the traffic, road transport has its undeniable advantages. Beyond a certain distance, for certain classes of transport service, railway transport is no less unquestionably preferable. Road and rail common carrier services will doubtless, to an increasing extent, examine together and in collaboration how they can effect economies, and give more convenient facilities at the minimum cost, by means of complementary service, though if such collaboration is to be successful the special position of the railways in regard to their rate system needs to be recognised. With such collaboration, for example, the "container system" can probably be developed and arrangements made for through rates, for collection and delivery by road and long-distance transport by rail, to an extent not otherwise possible and with results that would be of great benefit to trade and industry and to the whole economic development of the country.

Such collaboration, replacing over large spheres of their work the present competition between railways and road hauliers, but not eliminating it, should be possible as soon as the present atmosphere is improved, as we hope it will be by our recommendations. So far as we as individuals engaged in transport administration are concerned, we should certainly be glad to do all in our power to assist such a collaboration with the advantage of the relations which have developed between us as our discussions continued.

In conclusion, we desire to state that such a comprehensive measure of agreement has necessarily been arrived at by a process of give and take, and concessions on both sides. It is expressed in a scheme of which each section is an integral and interdependent part of the whole. It must not be assumed that if one part was rejected we should remain agreed upon the remainder. Conscious, therefore, that the rejection of one part of our scheme might endanger the whole, we have taken special pains in each sphere of our recommendations to avoid prejudice to absent interests. In view of this necessary interdependence of the various subjects we have dealt with we have tried to avoid any solution which might be acceptable to ourselves at the expense of others not represented. The incidence of highway costs which we recommend, for example, is not inconsistent with either a reduction, or a continuance, or an increase of the charges now levied on private motorists. Increases in the rates to be levied on the class of transport represented at our Conference do not prejudice the interests of other road users or either central or local revenue authorities. Moreover, our scheme does not deprive trade and industry of the practical convenience afforded by the existing liberty of the ancillary user.

As regards our specific calculations and assessments, it is obvious that they are in the nature of the case based to a considerable extent upon an appreciation of the importance of numerous factors upon which individual judgments will differ. Those who examine our proposals primarily from the point of view of any one of the main interests concerned will doubtless consider that we have given too little or too much weight to specific factors. But we venture to suggest that the fact that a Conference, composed, as ours is, of representatives of both railway and road transport, has been able to make unanimous recommendations, gives a strong presumption that, although we may have erred on this point or that, the scheme as a whole may be regarded as affording a fair basis upon which the different sections of the great inland transport industries can develop.

We have attempted to establish the main foundation for future development and expansion. We have not tried to elaborate a system in all its details, feeling not only that our time was too limited, but that such details would be better worked out by the authorities entrusted with the duty of dealing with problems of transport. Nor have we proposed a rigid and inelastic method of regulation which would be unadaptable to changing conditions and requirements.

GAS AND OIL ENGINE-DRIVEN AIR COMPRESSORS

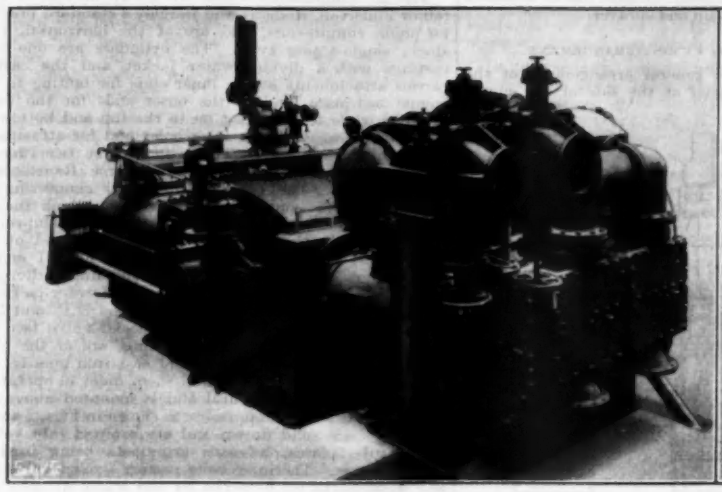


FIG. 1—THREE-CYLINDER GAS ENGINE SET—COMPRESSOR END

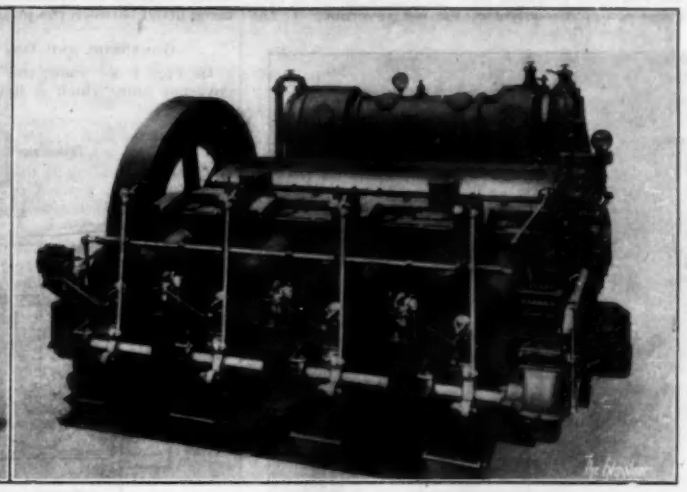


FIG. 2—FOUR-CYLINDER OIL ENGINE SET—ENGINE END

Vis-a-vis Gas and Oil Engine-Driven Air Compressors.

DURING a recent visit to the Sandiacre works of the Premier Gas Engine Company, Ltd., near Nottingham, we inspected on the test bed a 375 B.H.P., three-cylinder gas engine, and also saw a 480 B.H.P., four-cylinder gas engine of the horizontal type, both of which are directly coupled *vis-à-vis* to single-acting horizontal, two-stage air compressors, designed and built by Fullerton, Hodgart and Barclay, Ltd., of Paisley. These compressor sets have undergone an extended series of efficiency and fuel consumption tests, which were carried out by Mr. George E. Windeler, M.I. Mech. E., consulting engineer, of Manchester, and will, we hope, together with a description of the testing method and special apparatus used, form the subject of a later article. The accompanying engravings, Figs. 1 and 2, show two compressor sets, looking from the compressor and the engine cylinder ends respectively; while Fig. 3 is a longitudinal section through the cylinders of the gas engine-driven compressor set. In the table which follows the principal particulars of both a three and a four-cylinder gas engine-driven compressor set are given. The four-cylinder figures, we are informed, apply equally well to either a gas engine-driven or an oil engine-driven air compressor, the only difference being in the diameter of the power cylinders, a standard bore of 20in. being fixed for gas engines and 18in. for oil engines. In addition to the three and four-cylinder units illustrated, twin-cylinder engines of either type can also be supplied.

Engine and Compressor Particulars.

	Three-cylinder gas engine set.	Four-cylinder gas engine set.
Capacity free air delivered per minute, cubic feet	1710	2400
Delivery pressure, lb. per square inch	100	100
Altitude above sea level, feet	4300	750
Number of power cylinders	Three	Four
Bore of cylinders, inches	20	20
Piston stroke, inches	28	28
Engine speed, r.p.m.	200	190
Bore L.P. air cylinders	Two 19½in.	Two 24in.
Bore H.P. air cylinders	One 14⅜in.	Two 14¼in.
Output of engine at normal temperature and pressure, B.H.P.	375	480

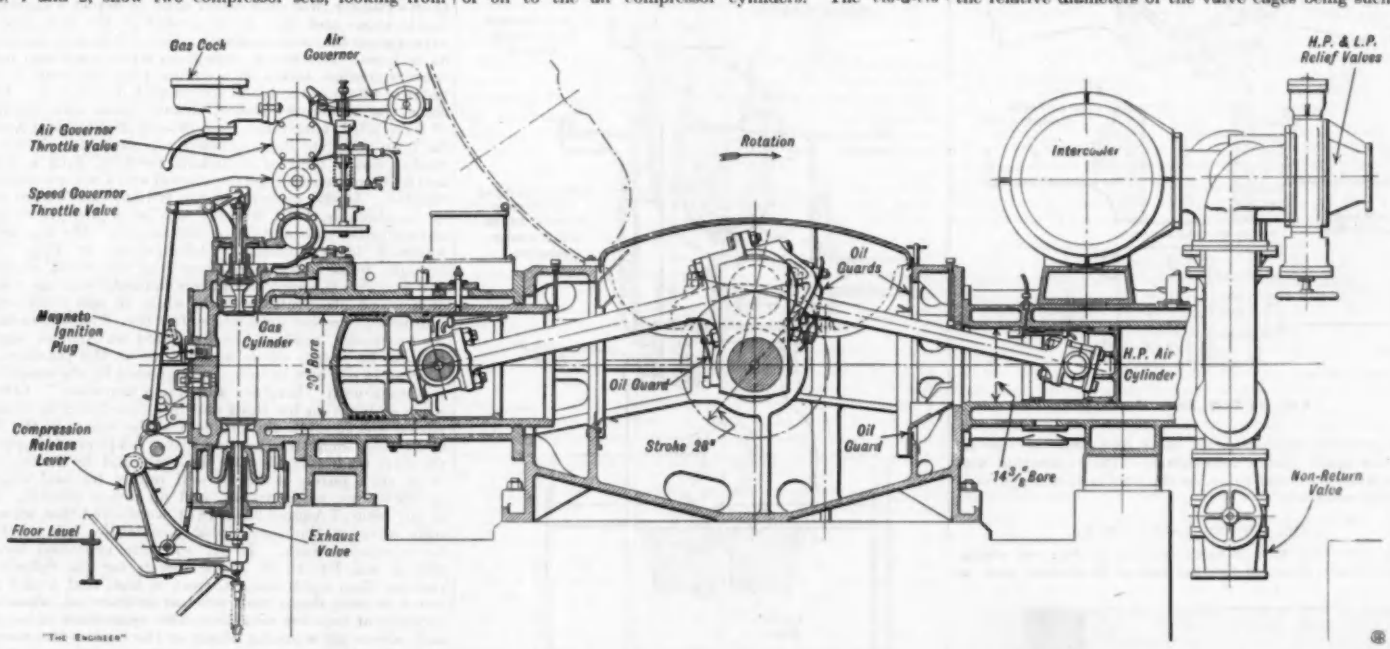


FIG. 3—LONGITUDINAL SECTION THROUGH GAS ENGINE-DRIVEN AIR COMPRESSOR

GENERAL ENGINE DESIGN.

The general design of the engines we are describing follows closely that of the firm's standard *vis-à-vis* type, an outstanding example of which is the 1000 B.H.P., eight-cylinder oil engine for Fen pumping, which was fully described and illustrated in THE ENGINEER of December 5th, 1930. From the drawing given in Fig. 3 it will be seen that the engine bed casting forms the centre section of the unit, on the left-hand side of which there is bolted the engine water jacket and liner casting; while on the right-hand side faces are provided to which the air compressor cylinders are bolted. Both sets of cylinders are further supported by stools which are secured to faces underneath the cylinder water jackets. A feature of the crank case casting is the provision of oil guards and sumps, which keep the used piston oil separate from the oil which is mechanically supplied to the big ends and crank shaft bearings, and also prevent the carrying over of oil to the air compressor cylinders. The *vis-à-vis* arrangement of the power and air compressing cylinders has permitted the use of a short, stiff crank shaft, which is designed to Lloyd's Survey requirements. The shaft is drilled for forced lubrication and the webs are recessed, so that the pistons can be withdrawn between them, with enough room for easy handling.

Special interest attaches to the design of the big end bearings for the opposed connecting-rods, which are illustrated in Figs. 4 and 5. These bearings are steel with white metal linings. Fig. 4 is a general view with the crank pit cover raised, while Fig. 5 gives sections through the bearings and the two rods. The big end on the engine or power side forms the master bearing, and extends the full width of the connecting-rod foot. It comprises the half bearing A, to which are bolted the two straps C, the bolts D taking the inertia forces. The compressor connecting-rod is attached to the opposing half-bearing B, the width of this bearing being the full length of the pin, but the attachment to the rod only half the length of the bearing, leaving the other half equally divided on either side for the bearings of the straps C of the engine bearing A. The small bolts E are only used for convenience in assembling, and do not carry any of the inertia forces. Adjustment of the bearings is provided for by shims inserted between the half-bearing A and the straps C. In practice these special bearings have been found to run smoothly and coolly, and the design is such that they are quite easily dismantled for inspection. The small ends of the connecting-rods are of the marine type, with adjustable phosphor bronze bearings. The pistons are of the trunk pattern, with a half boss, so that the connecting-rod and gudgeon pin can be removed if required, independently of the piston. Both compression and scraper rings are provided. Other main features common to both engines include a tee-section-armed split fly-wheel and an outboard bearing of the self-aligning, self-oiling type.

GAS ENGINE VALVE GEAR.

The inlet and exhaust valves are operated from a cam shaft running in self-oiling bearings, gear driven by bevel wheels from the crankshaft through a gear-driven side shaft, which is arranged below the cylinders, so that the removable circular plates on the ends of the cylinders which give access to the water jackets are readily reached. Both the inlet and the exhaust valves are arranged vertically over one another, the exhaust valve being at the bottom and the air inlet and gas valve at the top, the relative diameters of the valve cages being such that when the admission valve is removed the exhaust valve can be lifted through the same opening. Two springs are employed on either valve, and arrangements are provided whereby the springs of either valve can be changed while the engine is running. The valve levers are mounted on fulcrum pins, which oscillate in fixed bearings, and the cam rollers which engage with the single-operating cam are carried on roller pins on which there is a hand lever attachment which, when turned, moves the roller so that it engages with a raised portion of the cam, giving half compression for starting or full compression release for barring round. The engine is furnished with low-tension magnetos on all cylinders, which are actuated by an eccentric with a trip rod, which is worked from the cam shaft, the timing being capable of adjustment while the engine is running. As will be noted from Fig. 3, the ignition plug is placed directly above the centre of the cylinder at the back of the combustion chamber. Referring to Fig. 6, it will be seen that there are two throttle valves arranged in series between the main gas cock and the gas manifold, the lower throttle valve being operated by the main speed governor. When the set is started up and is running light the engine is controlled by the main governor, and the speed adjusted within certain limits by means of the hand-controlled speeder spring. The second valve is operated by the air governor, which consists of a differential piston loaded by means of a spring and weight. The air is led to the underside of this piston through a small separator,

and as the pressure approaches the normal working pressure of the set the piston rises, and doing so throttles the gas by means of the upper throttle valve. As the speed of the engine falls the lower throttle valve comes into the full open position, and the engine speed is then under the complete control of the air governor. If the

FIG. 4—VIEW OF BIG END

pressure, however, continues to rise, the air governor will still further throttle the gas supply and reduce the speed of the engine to a lower limit. Should the pressure still rise when the low speed limit of the engine has been reached, the automatic relief valves on the compressor come into action and completely unload the compressors. When this occurs the engine runs up to speed, and the

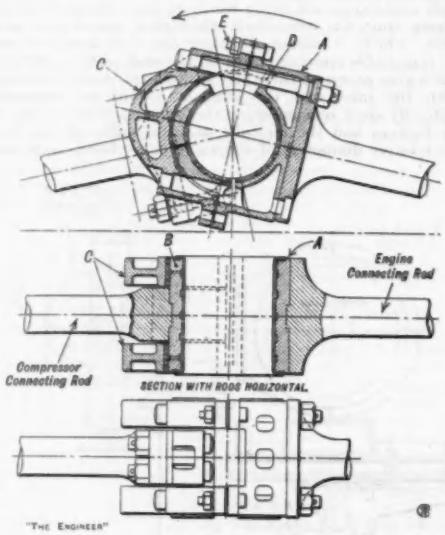


FIG. 5—BIG END DETAILS

main governor takes control until such time as the air governor again comes into action. This operation was demonstrated several times on the test bed, close governing being obtained.

OIL ENGINE VALVE GEAR.

The air inlet and exhaust valves of the oil engine follow closely those of the gas engine in design, and, as

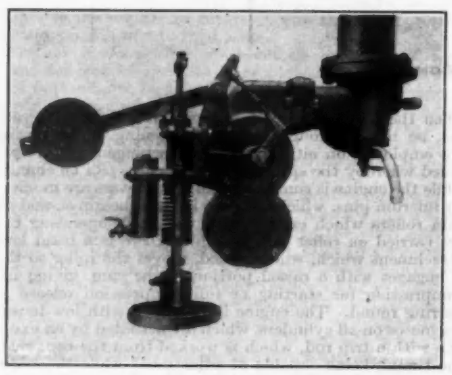


FIG. 6—GOVERNOR CONTROL VALVES

illustrated in Fig. 2, the fuel pumps, one for each cylinder, are mounted directly above the cam-shaft at the back of the engine. In the description of the 1000 B.H.P. engine previously mentioned there appears a detailed account of the fuel pump, the principal design points of which include its direct drive by means of a swinging lever carrying the cam roller, which presses against a guided sliding piece engaging with the plunger, a sliding wedge arrangement moved by the governor, which varies the lift of a mechanically operated by-pass valve. Each fuel pump has a hand priming lever, a hand-operated by-pass valve, and a hand adjustment for equally balancing the load between the various cylinders. The sprayer is of the automatic pressure-operated type, and is placed at the centre of the cylinder head, suitable fuel oil strainers being fitted between the pump and sprayer.

GOVERNOR AND OIL PUMP ARRANGEMENT.

In Fig. 7 we show the general arrangement of the governor unit, which is fixed at the side of the engine

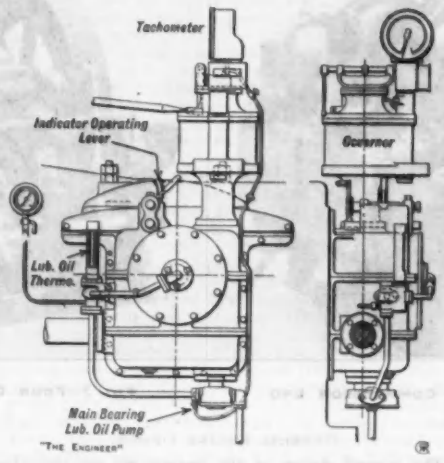


FIG. 7—PLAIN GOVERNOR UNIT

directly alongside the side shaft drive. Drawing Fig. 8 illustrates the actual drive along with that for the main lubricating oil pump, and the arrangement for operating the indicator gear levers, which can be put in and out of operation while the engine is running. The track rods from the governor to the gas valve and the fuel pumps respectively will be clearly seen in Figs. 1 and 2. The governor is of the enclosed centrifugal, spring-loaded pattern, directly driven from the crank shaft through screw gearing, the drive being extended to a tachometer mounted on the top of the governor. As shown in Fig. 8, the main lubricating oil pump, which supplies the crank shaft and main bearings, is driven from the lower end of

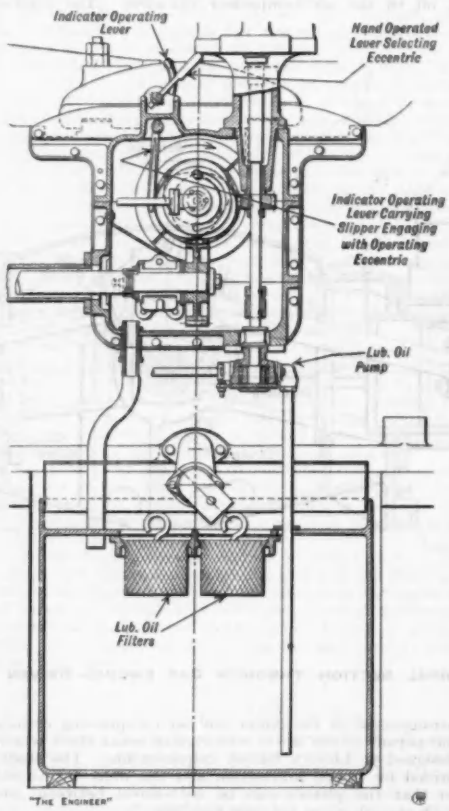

Indicator Operating Lever
Hand Operated Lever Selecting Eccentric
Indicator Operating Lever Carrying Slipper Engaging with Operating Eccentric
Lub. Oil Pump
Lub. Oil Filters
"THE ENGINEER"

FIG. 8—LUBRICATING OIL PUMP AND MECHANISM

the governor spindle. It draws its supply from the oil tank immediately below it and delivers oil through the end of the crank shaft, a pressure gauge and thermometer being interposed in the pipe line between the pump and the shaft, as indicated in Fig. 7. The surplus oil is by-passed over the governor gears and passes down into the side shaft oil tank. A twin filter is fitted between the tank and the engine, and is so devised that one filter cage can be cleaned while the engine is running. The lubricating oil for the pistons and small ends is supplied by double plunger forced feed lubricators driven from the cam-shaft. In the case of the pistons there is only one feed to the liner top on each cylinder, the oil gravitating down, giving very efficient lubrication. As previously indicated, planished steel oil guards are fitted, which are hinged so that the whole of the parts within the crank case and in front of the pistons can be exposed in a few minutes.

The engines are started by compressed air supplied at about 250 lb. per square inch, which is admitted to two cylinders. The main stop valve is hand-operated, but the air is supplied to the cylinders through cam-actuated distribution valves and non-return valves.

THE AIR COMPRESSORS.

The air compressors which are shown in Figs. 1 to 3 follow Fullerton, Hodgart and Barclay's standard practice for mine compressors, and are of the horizontal, two-stage, single-acting type. The cylinders are one-piece castings with a divided water jacket, and the casting carries attachments at the inner ends for bolting to the engine bed-plate, and at the outer ends for the valve headers, while feet are cast on to the top and bottom of the cylinder to carry the intercooler and for attachment to the supporting stool. The pistons carry two rings of the double seal Ecliptic type, and three Ramsbottom scraper rings. The crosshead pin and connecting-rod do not call for comment. The valves, which include suction and delivery valves, relief valves and non-return valves, are all arranged on headers at the end of the compressor, which are clearly shown in Figs. 1 and 3. The headers are cast in one piece with suitable divisions for the suction and discharge sides and are water-jacketed. All the valves, with the exception of the H.P. and L.P. relief valve, which is fitted with a special valve face and is piston-operated by the air pressure, are of the plate type, with mild steel seatings and cast iron guards, and are interchangeable. We found them quiet in operation. The intercooler is horizontal and is mounted above the cylinders of the air compressors, as shown in Figs. 2 and 3. The tubes are solid drawn and are screwed into yellow metal tube plates, asbestos grummets being used as packing rings. The intercooler carries a relief valve and also drain cocks for both the air and water spaces. The flow of air is round the tubes, and the design is such that ample cooling surface is provided. The control valve for the pressure relief valves previously referred to is of the piston type, and is automatically operated by the rise and fall of the air pressure in the receiver. When operated, air is admitted into the control cylinders on the top of the relief valves, quickly opening them and releasing the accumulated pressure.

The internal combustion engine-driven compressor sets we have described are two of several now going through the Sandiacre Works for service in mines overseas, and the design is one which further extends in a useful manner the *vis-à-vis* Crossley Premier engine, which is also being applied for generator driving, pumping and marine work.

SIXTY YEARS AGO.

IT is on record that Dibdin, a better poet doubtlessly than a painter, was once called upon to depict a theatrical battle scene and that he succeeded in the task beyond expectation by painting smoke whenever he was uncertain as to form. Not much more than sixty years ago map-makers treated Africa on a similar plan and were in the habit of filling in the blank spaces with desert sand. Then came the explorers—Baker, Grant, Speke and, greatest of them all, Livingstone—who proved that Central Africa, far from being the burning waste represented in the school books, was a land of abundant fertility, with a dense and by no means debased population and a not uncongenial climate. At the meeting of the British Association held at Brighton in 1872, Stanley was in a position to give authoritative information on the subject. He was newly returned from "finding" Livingstone at Ujiji. He brought home despatches from the renowned explorer and was able to supplement their contents with the results of his own observations made while he and Livingstone journeyed together for a while after their historic meeting. As testimony, perhaps, he exhibited an African pigmy, Kalulu, by name, whose appearance on the platform, so we read in our own columns, was greeted by the assembled scientists with "laughter and much applause." Livingstone's object on his third and last expedition to Central Africa was to settle the problem of the source of the Nile and to take such steps as were within his power to suppress the slave trade carried on by the Arabs and the Portuguese. With such purely scientific and purely humane objects as these, we, as engineers, had no direct concern, but, in our issue of August 23rd, 1872, we showed that we were fully alive to the commercial possibilities lying behind Livingstone's work. Ivory, so little esteemed locally that it was left to lie in the forests for the rodents to sharpen their teeth against, trees so high that a shot gun failed to bring down birds perched on their top, abundant supplies of iron ore and illimitable quantities of copper, and, above all, a strong liking on the part of the natives for calico, brass ornaments and beads—these features, we argued, might be made the basis of a highly remunerative trade. To develop it, we suggested, a railway should be constructed penetrating inland from the coast opposite Zanzibar. Such a railway, it would appear, would be capable of being constructed without great expense, for the land was substantially level and had no wide chasms to cross or mountains to penetrate. Incidentally, we believed that the construction of such a line would prove the best means of securing one of Livingstone's objects, the suppression of the iniquitous slave trade. Even as we wrote, Livingstone was setting forth, reinforced with the aid supplied through Stanley by Gordon Bennett of the *New York Herald*, on his last forlorn journey in search of the fountains of the Nile, a journey which was to end at Chitambo's village on the Lulimala on May 1st, 1873, and a year later at Westminster Abbey.

THE official returns rendered to the Electricity Commissioners show that 806,000,000 units of electricity were generated by authorised undertakers in Great Britain during July, compared with the revised figure of 785,000,000 units in the corresponding month of 1931. During the first seven months of 1932 up to the end of July, the total amount of electricity generated by authorised undertakers was 6,895,000,000 units, compared with the revised figure of 6,424,000,000 units, for the corresponding period of 1931, representing an increase of 7·3 per cent.

Railway and Road Matters.

As from November 1st, the Great Western and the Southern will no longer have their separate staffs at the ports in the Channel Islands served by their respective steamers, but will have a joint staff. The headquarters of the Great Western will be in Guernsey and those of the Southern in Jersey.

THE first section of the Cockfosters extension of the London Underground Railways will be opened from Finsbury Park to Arnos-grove on September 19th. There will be stations at Manor House, Turnpike-lane, Wood Green, Bounds Green, and Arnos-grove. The remainder of the line will be opened next year.

IN redemption of a promise made by the Chairman, Sir Arthur Salter, that the Minister of Transport should have the report of what is known as the Road-Rail Committee by the end of July, Sir Arthur presented the report to Mr. Pybus on July 30th. According to a lobby correspondent, the latter gentleman was at Downing-street on Wednesday, August 3rd, on which day there was a meeting of the Cabinet. The report has now been issued as a Stationery Office Publication, price 1s. 3d.

MANY of our readers in North Staffordshire and Cheshire will remember Mr. W. D. Phillips, as he was for thirty-seven years the general manager of that valuable little bit of railway property—the North Staffordshire Railway. From that position he retired in 1919, but as he was nominally retained as consultant general manager he was to be found on most days at the headquarters at Stoke-on-Trent until the company was absorbed with the London, Midland and Scottish at the end of 1922. We take advantage of this note—which is to record that Mr. Phillips died at the age of ninety-three on August 11th—to refer once more to the appointment of engineers as railway general managers, as Mr. F. A. Lowry Barnwell, the company's chief engineer, succeeded Mr. Phillips as general manager.

THE future of Crewe Works has been mentioned in these pages on three or four occasions of late, but the most serious news is that recorded in our Seven-Day Journal this week. In connection with Crewe we would have it remembered that herein on July 1st Sir Josiah Stamp was reported to have said that, quite unconnected with the question of steel manufacture, he had under consideration the concentration at Crewe of certain subsidiary activities which would tend to maintain the status of Crewe as one of the important L.M.S. centres. That remark has come back to our mind by the Crewe correspondent of the *Manchester Guardian*, in the issue of that paper for August 9th, saying that the signal and telegraph department at Derby is to be removed to Crewe. It is important that we should add that this may apply only to the administration—which is at Derby—and may also mean the closing of the signal and telegraph works at Derby and their concentration in the shops at Crewe.

THE report of Colonel Trench into the collision of June 10th at Hammersmith, mentioned herein on June 17th, was issued on the 12th instant. As the latter date was exactly nine weeks after the accident, such dispatch might be used in evidence against the Ministry of Transport when apparent delay arises, as was with the case related herein on July 1st with the Dagenham report. The present instance is, however, the report observes, "a simple one, the more so in view of the frank admission of his mistakes which was made by the motorman concerned. The train driven by that man stood on a siding which had a connection to the left to No. 2 platform, and to the right to No. 3 platform. Both signals were against him, but just ahead of where he stood was the signal for the adjoining running line. That was "off" for an approaching train, but the man with the standing train took it as his and started. His train was at once "tripped" and the man then made his second mistake, in that he assumed that the train-stop had failed and he thereupon released himself and proceeded and the collision followed. A point that puzzled us has been cleared up by Colonel Trench's report. There is a trap point in the siding which should ordinarily have kept back the standing trains when the main line signal was "off" and the siding points lay for the left. It appears, though, that such interlocking was deliberately not provided, as reliance was placed on the train-stop of its signal. The trap is now to be replaced by a sand drag.

IT cannot be regarded as other than a happy coincidence that a fortnight after our article on the Leicester and Swannington Railway appeared—on August 5th—we have to record the centenary of the sequel to the opening of that railway on July 17th, 1832. The story of what happened was related at some length in that article of our series "One Hundred Years of British Railways," which appeared on October 24th, 1924. In passing it should be brought to mind that the Liverpool and Manchester Railway of 1830 was mainly constructed because the Mersey and Irwell Navigation and the Bridgewater Canal authorities refused to reduce their charges. Similarly, the coalowners of Derbyshire and Nottinghamshire were at the mercy of the Erewash Canal Company, which carried the coal to the river Trent. The opening of the Leicester and Swannington Railway gave the South Leicestershire coalfields an advantage over their northern neighbours. The latter knew, from personal experience, the benefits of railway communication, as they had had, for some thirteen years, a railway from Pinxton, on the Cromford Canal, to Mansfield. That was the Mansfield and Pinxton Railway, sanctioned in 1817 by 57 Geo. III. C 37, and opened in 1819. A railway was therefore proposed from Pinxton to Leicester, and on the 16th of the present month it will be 100 years since that scheme was proposed at a meeting at the Sun Inn, Eastwood. The promoters sought the help of the Liverpool and Manchester people, who agreed on conditions that the line went beyond Leicester to Rugby and was there to join the London and Birmingham Railway. The Midland Counties Railway was the result, and it was opened from Derby to Nottingham on May 30th, 1839, and from a junction on that line at Trent to Leicester on May 5th, 1840, and thence to Rugby on July 1st, 1840. There was no railway communication, however, along the Erewash Valley until 1847.

Notes and Memoranda.

ACCORDING to *Industrial Gases* paint can be burned off steelwork on shipboard with an acetylene-air blow-pipe about six times faster than with a paraffin blow-lamp.

IN putting in the foundations for an auditorium reaching out into the sea at Long Beach, California, it was found very difficult to drive the piles down through the clay bottom of the beach. As a consequence the contractor bored holes in the clay with a rotary drill to within 3ft. or 4ft. of the designed length of the piles, dropped the piles in the holes and then drove them the remainder of the depth. It is said that the bearing qualities of the drill-driven piles were inappreciably less than that of wholly driven, while the time occupied was halved.

THE acreage of timber land in the national forests destroyed by fire during the first half of this year in the United States of America was 46 per cent. less than that for the same period in 1931. Altogether, 51,514 acres was burned, compared to 96,228 acres during the first half of last year. An improvement in climatic conditions and a decrease in the number of man-caused fires have contributed to the reduction. Officers of the forest service, Department of Agriculture, believe that new roads, trails and equipment and improved technique, based on the experience of past years, will continue to improve the fire-suppression record.

THE South Wales Electric Power Company of Cardiff is distributing pamphlets to farmers giving them useful information on the advantage of the electrical heating of the soil in frames used for growing vegetables and fruit for the early market. The soil is heated by means of a "thermal" cable buried in the soil and carrying at certain times of the day electric current. British and Continental firms are now manufacturing this kind of cable, and an electrical contractor will install it. This pamphlet demonstrates by photographs how much more rapidly a cucumber will grow in an electrical hotbed than in an ordinary frame.

IN an article on the protection of aluminium against corrosion by plating, Mr. E. E. Halls, in the *American Machinist*, says that in all circumstances it must be granted that methods of protection based on enhancing the oxide film properties demand first attention. Electro and chemical processes of "anodising" are meeting with success, and work so treated will withstand several months of salt spray or outside atmospheric conditions without failure, results that are not achieved by commercial platings. Further, anodised surfaces are not unpleasant and may be coloured by simple processes. Regarding adherence, it is logical to expect the relative thermal characteristics of base metal and coating to play a prominent *rôle*, especially under tropical conditions when abrupt changes occur between day and night.

RECENTLY some 1000 square feet of wall, covered with dry-rot, were "cured" at the offices of the Clyde Valley Electrical Power Company in Glasgow by scorching with the oxy-acetylene flame. Naturally, it was essential that no affected part should be missed, and, to be sure of this, use was made of a large multi-jet nozzle, formed from a copper pipe having twelve No. 4 tips attached to a No. 15 "Universal" blow-pipe shank. When testing this blow-pipe some trouble was experienced with back-firing, caused by splintering brick and mortar. This was overcome by the introduction into the gaseous mixture of a small quantity of coal-gas—in the proportion of about 1 part coal-gas to 12 parts acetylene. The job was successfully carried out in a gross time of twelve hours with gas consumptions of 600 cubic feet oxygen, 500 cubic feet dissolved acetylene and 40 cubic feet coal-gas.

THE testing of welds by means of the stethoscope has been described by Messrs. Kinzel, Burges and Lyth in the *Journal* of the American Welding Society. It has been found that by placing the end piece of the stethoscope near the weld and tapping with a hammer along the weld, discontinuities may be readily detected, which makes the process extremely simple. The stethoscope is tipped with a gum rubber cap to exclude extraneous sounds and give a contact on the irregular surface of the plate, as well as to minimise damping of the oscillations at the contact of the stethoscope and metal. On tapping, the initial sound heard is critical. Each welded structure has a characteristic sound. After this is determined by brief preliminary tests, differences in sound as the hammer is applied to the weld may be readily noticed. The method has been tried on welds in steel plates, pipe welds, pressure vessel welds and welded structural steel joints. It has been found that defects which affect the strength of the weld 5000 lb. or more are readily discernible, and any lack of fusion at the bottom of the single vee is strongly evident.

A DESCRIPTION of the manufacture of porcelain electrical insulators is given in *Vista*, the house journal of British Porcelain Company, Ltd., London, S.W.1. Each piece of porcelain is carefully inspected by factory inspectors immediately after removal from the kiln, and all pieces failing to pass this inspection are destroyed. To find the porosity, fragments of the porcelain are placed in fuchsine dye and subjected to a pressure of 2000 lb. per square inch for twenty-four hours. They are then removed, carefully dried, and broken to find out whether there is "penetration" or not. If any is noticed, the representative batch of insulators is destroyed. The thermal test consists in immersing the porcelain in boiling water and then in iced water for periods of ten minutes, one hot and one cold test constituting a thermal cycle. After five such cycles, the porcelain is flashed over to test for thermal failure. After further thermal cycles, the insulators are subjected to a flash-over test. They are next subjected to a flash-over test at a frequency of 250,000 cycles per second. This test has proved a boon to the industry, as it eliminates porcelain with dielectric defects. In assembling the insulators, Portland cement with a definite proportion of pure water is used. They are allowed to stand five days before being cleaned and treated with weather-proofing compound, and after three more days a routine tension test is applied. The final tests are made in the presence of the customers' inspector, who sees the large completed insulator.

Miscellanea.

THE old Whitehall shipyard at Whitby, which has been in existence since 1790, has been closed down.

THE Anglo-South African telephone service has been extended to include Johannesburg and Pretoria.

A PLANT for the production of liquid sulphur-dioxide on a commercial scale is being put up at Hamilton, Ontario.

ALREADY over 90 per cent. of the space available at Castle Bromwich for next year's British Industries Fair has been let.

IT is announced that Clarke, Chapman and Co., Ltd., of Gateshead-on-Tyne, have made 33,000 steam winches during the last twenty years.

THE new pumping plant of the Godalming Corporation, Surrey, is to comprise a three-cylinder Ruston oil engine driving three Mather and Platt centrifugal pumps.

ATTEMPTS are being made to salve the cargo of copper, sunk in the Spanish steamer "Noviembre" off the mouth of the Gironde in 1917. It is said to be worth about £140,000.

BRITISH purchases of German goods dropped in value from £7,515,000 to £3,915,000 during the second quarter of this year; whilst German purchases from Great Britain declined from £4,210,000 to £2,945,000.

THE Chinese Government has ordered some £100,000 of railway material in this country, the contract being distributed between the Dorman, Long, Barrow Hæmatite, Guest, Keen, and Lancashire Steel companies.

TOTAL paralysis of the Chinese Eastern Railway, widespread damage to crops and property, and what is expected to prove very heavy loss of life, have been caused by the flooding of the Sungari and other rivers of Central Manchuria.

THE Council of People's Commissars of the U.S.S.R. has decided that the work of cutting the canal between the Volga and Moscow rivers is to be begun at once, and the completion of the canal is fixed for not later than November, 1934.

TWO-THIRDS of the concrete has been poured for the lining of the diversion tunnels at Hoover Dam, United States. At the close of the week ending July 23rd, practically 10,000ft. of tunnel lining had been put in place. The total length of the four tunnels is 15,900ft.

A GRAIN-CONVEYING, elevating, weighing and discharging plant with a capacity of 20,000 tons, is to be put up at the Imperial Dock, Leith, by Henry Simon and Co., Ltd., of Manchester. The pneumatic ship-discharging plant will be supplied by Robert Boby, of Bury St. Edmunds.

IT is proposed to construct a new railway bridge across the river Narbada at Broach to replace the existing structure, which has been in service since 1881. It is supposed that the new structure will be about 4600ft. long, and that it will consist of about sixteen spans.

A LIGHTHOUSE for the combined guidance of shipping and aircraft has been erected on a reef near the island of Penedos de Sao Pedro, off the Brazilian coast. It is said to be the most brilliant on the South American Coast, and is supplemented by an emergency light, which automatically comes into action should the main light fail.

THE grain galleries for loading ships at Churchill, the terminus of the Hudson Bay Railway, are rapidly being extended, report the Canadian National Railways. Last year five grain spouts were in use for loading, but this season the galleries will be extended for 1400ft., the length of the wharf, when twenty-three spouts will be available capable of loading simultaneously four ships in one day.

THE Mining Association of Great Britain is, says the *Iron and Coal Trades Review*, contemplating presenting to the Science Museum at South Kensington a full-sized reproduction of a mine gallery, complete with modern mining machinery, in order that the coal industry shall be adequately represented in the new block of the Museum when it is built. Lord Gainsford represents the Mining Association on the Advisory Council of the Museum.

BRITISH designs are involved in two important orders for aeroplane engines just issued on the Continent. The Danish Government has decided to have fifteen "Bulldog" fighters, which will be built under licence in that country. They will have engines of 560 horse-power each. The Belgian Government, also, has given an order for a number of Armstrong-Siddeley engines, which will practically eliminate from the Belgian Force all but British engines.

A NEW site has been selected for the North Railway station at Shanghai, to replace the terminal wrecked during the late riot. The new station will be constructed near Chenju, at the junction of the Shanghai-Nanking and Shanghai-Hangchow railways. Pending construction of the new depôt, which will be started as soon as the approval of the Ministry of Railways is secured, the present North Station will be repaired for temporary use. In the meantime, repairs to the Woosung railway workshop and other property of the two railways are being considered.

THE Secretary for Mines announces the publication of the Report of the Advisory Committee for the Metalliferous Mining and Quarrying Industry on the Possibilities of Developing or of Reviving the Working of Metalliferous and Associated Deposits in Great Britain. The Committee has made a survey of the whole of the metalliferous mining and quarrying industry in this country, and its report includes recommendations on the following matters:—(*a*) The stimulation of the consumption of pig iron produced from home ores; (*b*) the reduction of railway charges; (*c*) the extension of part of the Mining Industry Act, 1926, to apply to metalliferous minerals; (*d*) the taxation of mining plant and property; (*e*) geophysical surveys; and (*f*) a proposed drainage and transport tunnel for the Camborne-Redruth tin-mining district. An appendix to the report contains tables giving particulars for a series of years of the production, value, imports, and exports of certain metalliferous and associated minerals, and of the prices of metals. The report may be obtained from H.M. Stationery Office, price 6d. net, 7d. post free.

THE IRONBRIDGE POWER STATION OF THE WEST MIDLANDS JOINT ELECTRICITY AUTHORITY

E. F. HETHERINGTON, M.I.E.E., M I. MECH. E., ENGINEER

(*For description see page 174*)

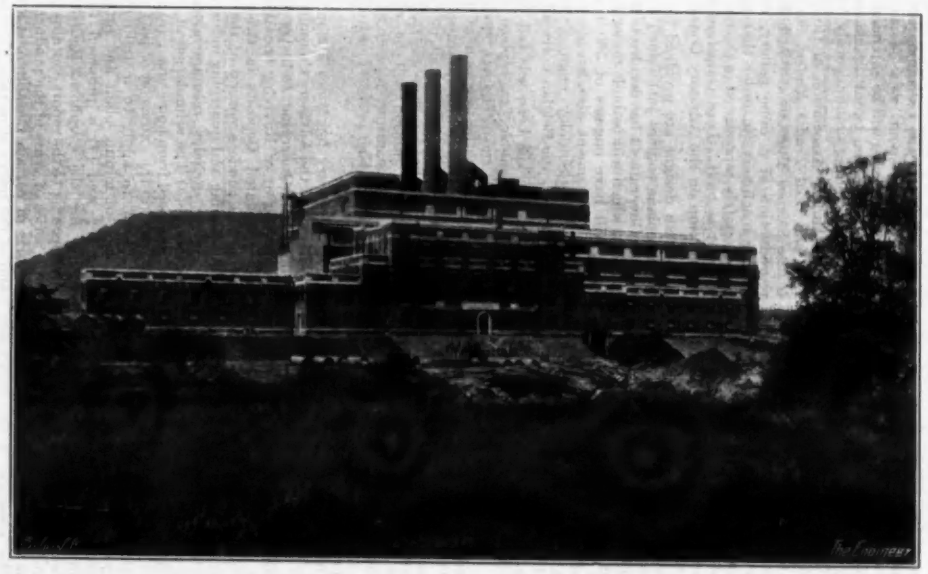


FIG. 10—FRONT VIEW OF POWER STATION SHOWING SWITCHGEAR AND OFFICE BLOCK

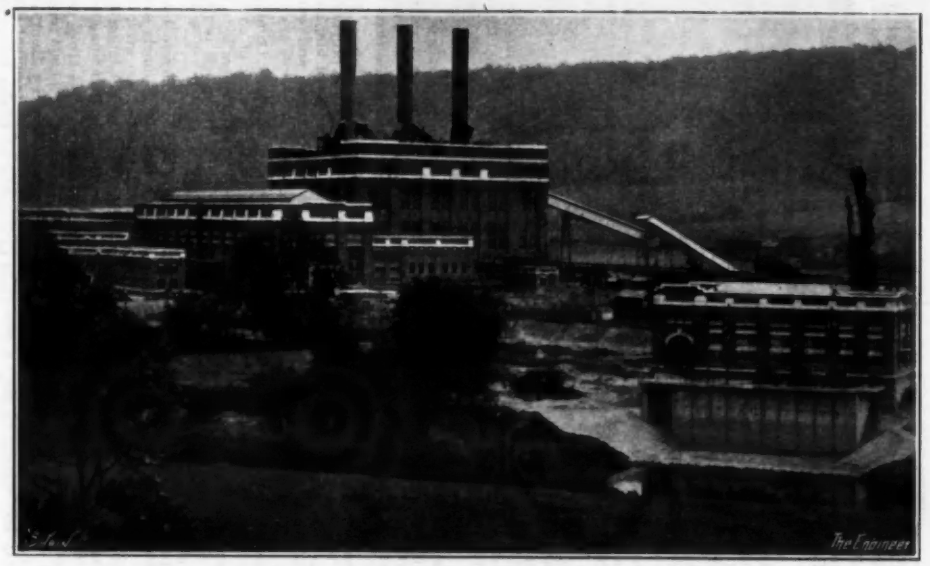


FIG. 11—POWER STATION AND CIRCULATING WATER PUMP HOUSE

FIG. 12—BRIDGE ACROSS THE RIVER SEVERN

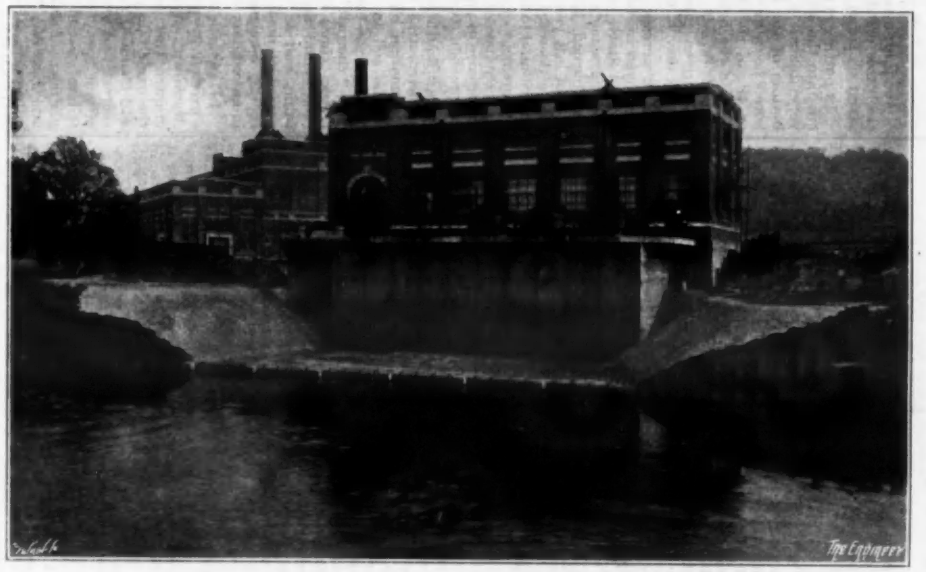


FIG. 13—CIRCULATING WATER PUMP HOUSE AND INTAKE

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NOTICES TO READERS.

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HONOUR WHERE IT IS DUE.

MAN has never yet succeeded in formulating rules for his own conduct which never cause hardship and are never inequitable. Even if they are perfect at the time of drafting, circumstances change with the flux of time, and by almost invisible steps new conditions which call for their revision arise. Amongst laws which have suffered this fate are those controlling the professional conduct of the members of certain societies. They were drawn up many years ago, when life was less intense than it is now and when the professional man was expected to maintain a position of dignified detachment. But by degrees anomalies have crept in and rules which once were not only admirable in intention, but excellent in practice, have now an inequitable effect. An outstanding example is the stipulation that the professional man, be he doctor, lawyer, or engineer, must not advertise. It is with the last-named that we are here concerned. Observe the anomaly that results. A professional member, let us say, of the Institution of Civil Engineers must observe the rule, but if a member happens to be connected with a firm of manufacturers or contractors, his firm—and since the less is contained in the greater, he also—may do as it pleases. Hence, for example, we may see a bridge under construction plastered with the names of the main and sub-contractors for all the world to behold, whilst the name of the engineer who has conceived the design and who is responsible for its fitness for its purpose is only to be found on drawings and letters which are hidden from the public. It is scarcely surprising that in these circumstances the name of the engineer is unknown or forgotten whilst that of the builders is stamped upon the memory.

The consulting engineer and independent designer is too generous to stop, as he could if he so desired, the exhibition of name boards by contractors, but at the same time he cannot but be conscious of the unfairness of a procedure which robs him of his due credit and gives it, in the public eye, to those who are working under his direction. It is this unfairness, this lack of recognition, which stings him most; but under modern conditions he may suffer in his pocket as well as in his feelings. Many contractors are quite prepared to submit their own designs and to do all the work that used to be done by the independent professional engineer. There is but little to be said against that course, for many contractors are served by admirable designers. But what is "sauce for the goose is sauce for the gander." If the contractor is allowed to blazon his name on his works, then it would seem but fair that the consultant should be allowed to do so as well. Is it not an absolutely anomalous position, as we have already indicated, that if the contractors' designer happens to be a member of the Institution he may enjoy the benefit of advertising through the name of his firm whilst, if he is independent, he must hide his light under a bushel? The consultant, it will be said, has means of securing the credit which is due to him. What do they amount to? He may read papers before learned societies or he may give particulars to the technical Press. But in the former case he is almost certainly addressing those who are already familiar with his responsibilities, and in the latter he does not reach the general public. In neither does he get the publicity which the contractor secures by the exhibition of his name plate and by his freedom to advertise how and when he will. Only recently our attention was directed to an article in a daily newspaper which presented a journalistic description of a notable bridge. The name of the contractors was given, but the firm of consultants which had designed the structure was not mentioned in any way. The contractors, we are confident, are not to be held responsible for this oversight. From long experience we know that they are always careful to give honour where it is due. No doubt the journalist who wrote the article copied down the names plastered upon the works—and that of the engineers was not amongst them.

We are not concerned now with the employment by professional engineers of advertising for business purposes; that is a subject which is receiving the attention of two or three influential bodies. Our desire is to see honour done to those men who merit it. It is scarcely for us to suggest the means by which that end could be secured, for that is a matter entirely for the consideration of the councils of the societies and institutions whose regulations for professional conduct may call for modification. There are, we are aware, still not a few members who hold tenaciously to the old dignified rule and who find sufficient reward in the consciousness of work well done—and substantial fees. Equally, there are many who would be content to go without public recognition themselves if it were not given to others. But to expect the engineer or architect to tolerate patiently the supersession of his own name by that of his contractors and builders is asking too much of human nature. Sometimes, when it is difficult to draft a general rule, it is better to make a special regulation. In such cases as we have been discussing permission to engineers to place their names upon works for which they were responsible would remove the present unfairness. That, combined with greater care upon the part of the daily Press, would ensure that honour was given where it was due.

Labour and Railway Pools.

THE pooling scheme of the London, Midland and Scottish and the London and North-Eastern Railways had, in effect, only two opponents. Certain trade organisations entered an appearance, but the degree of that opposition may perhaps be gauged by the fact that all were represented by one barrister. Even that opposition was withdrawn on the last day of the hearing, when counsel for the railway companies replied to the objections, and the scheme then went forward with the support of the traders. The other opposition came from the railway unions, whose contention was that the pooling scheme was essentially one of amalgamation and, that being so, the compensation clauses of the Railways Act, 1921, applied. In order that that point may be appreciated we would say that the third schedule to that Act provided, briefly stated, that every officer or servant dispensed with or who suffered any pecuniary loss by reason of amalgamation—*e.g.*, under the grouping ordered by that Act—should be entitled to compensation. The answer of the companies to that contention was that it was not an occasion to which that obligation applied, but, their counsel added, they would not, as a consequence of the pooling, dismiss any member of the staff falling within any of the conciliatory or salaried grades—the "conciliatory" grades are the 600,000 odd men engaged in the operation of the railways—who was in their service on July 1st, 1932. The age of retirement might, however, be reduced and men might have to be moved or reduced in rank, with or without a reduction in pay. The Committee which considered the scheme on behalf of the Minister of Transport apparently regarded this as a generous offer, as its report said that under the companies' proposals every man was "secure of his job," and whilst it did not feel justified in pressing the unions to accept the offer, it considered that the undertaking given was, in all the circumstances, a fair basis of settlement between the parties.

Whilst the opposition of the railwaymen can be readily understood, and is fully appreciated by the companies, it is clear that the unions are stretching the point too far when they say that a scheme to reduce expenses by pooling competitive receipts is of the nature of an amalgamation. True, by the concentration of their facilities economies are effected, but economies are secured by other means also, that have unfortunately led to men's services being dispensed with or their being reduced in rank. The fact is that the men got spoilt, their occupation sheltered, and their unions made all-powerful by Mr. Lloyd George in 1918 and 1919. We have passed through so much during the last fourteen years that it is now forgotten how railwaymen of every grade were given the eight-hour day. It seems incredible now that in August, 1917, despite the serious national position at that time, the Associated Society of Locomotive Engineers and Firemen—the representatives of what is admittedly the cream of the railway service—threatened to strike and their ultimatum was withdrawn within a few hours of its expiration only on the promise of the President of the Board of Trade—a promise which had to be confirmed in writing—that within a month of the cessation of hostilities the Government would give sympathetic consideration to the men's demands for a shorter working day. The sequel to that promise was that on December 6th, 1918—less than four weeks from the Armistice, but a week before the General Election!—all railwaymen were given the eight-hour day at a meeting at which the railways were not officially represented and about which the companies were not consulted. On the instruction of the Government the Railway Executive Committee—the railway general managers who worked the railways for the Government—held meetings with the unions in March, 1919 and subsequent months in redemption of the promise—also made in August, 1917—that their pay and conditions of service should be reviewed. Certain points, such as a guaranteed week and payment for overtime and Sunday duty, applicable to all grades, were settled in the National Agreement of March 27th, 1919. Each section was then to be dealt with in detail. What was conceded to the drivers and firemen was a sample of the all-round generosity. All drivers were given a maximum of 15s. per day, and thus those on shunting engines got an increase of 150 per cent. over their pre-war rate; local passenger train drivers had 114 per cent. more and express drivers an increase of 87 per cent. The result of the eight-hour day made the mileage for a day's pay into 120 instead of 150 and, consequently, a Great Western driver earned a day's pay in taking a train from Paddington to Bristol in a morning and another day in taking it back in the afternoon. The 150-mile has since been restored, but a driver on the "Royal Scot" link earns four days' pay in the trip from Euston to Carlisle one day and back the next. The National Union people were evidently annoyed at the enginemen getting such favours, and so quickly, and suddenly, like a bolt from the blue, came the general railway strike of September–October, 1919, which ended with equal suddenness after a talk, one Sunday afternoon, between Mr. Lloyd George and Mr. J. H. Thomas. The settlement which ended that strike contained a clause that wages were to remain at their then level for at least another year and that no adult railwayman was to receive less than 51s. per week as long as the cost of living was not less than 110 per cent. above pre-war level. A point as to which, finally, our memories need to be sharpened is that at that time the railways were under Government control and that, according to Mr. Whitelaw, speaking in Glasgow in the following March, the Railway Executive Committee acted on the instructions of the Government.

It is these labour conditions, even more than road competition, that handicap our railways. It was stated before the National Wages Board on January 19th, 1931, that the railway wage bill had increased from 47 millions in 1913 to 114 millions in 1929, a rise of 143 per cent., and that the general

level of wages, including the railways, was 70 to 75 per cent. higher. Figures as to the business done were not given, and we may supply the deficiency by saying that in 1913 the gross receipts from railway working were under 120 millions and in 1930 they were under 185 millions, an increase of less than 55 per cent. That increase was, of course, fictitious, as the rates and fares were higher; the tonnage of freight, for instance, was 326 millions in 1930, as against 365 millions in 1913. The pay of most of the men whose wages and conditions of service were so generously dealt with comes under the heading of "Traffic Expenses," and a comparison of the reports of the four grouped companies for last year shows that, in contrast with the rather good year of 1925, whilst the railways have reduced their combined maintenance of way and works by 21·37 per cent. and the maintenance of their rolling stock by 17·11 per cent. they have made only a saving of 14·09 per cent. in their traffic expenses, despite a drop of 17·70 per cent. in the gross traffic receipts. If, then, the cry of injustice or harsh treatment be raised it can be answered that a reduction of expenses is absolutely necessary to enable the railways to supply a fairly efficient service. These steps of the companies are forced upon them and would appear less unkind but for the action of the Governments of 1918–1920, which gave extravagant concessions to the railwaymen and left the companies to bear the brunt.

Road and Rail Transport.

It may be hoped, with reasonable confidence, that the report of the Conference on Rail and Road Transport which has just been issued will do much towards terminating acrimonious debates which have served no good purpose, but have, rather, tended to hide fundamental economic principles. The report has been presented to the Minister for Transport with the unanimous approval of the highest representatives of the railway companies and road interests, acting under an independent chairman. Into its composition there has entered a spirit of give and take which was far from being evident in the discussions by disputants up to a few weeks ago, and we shall be disappointed indeed if the publication of the report does not inaugurate an endeavour to make the best of road and rail transport for the benefit of the community and the country as a whole. "Collaboration," says the report, "replacing over large spheres of their work the present competition between railways and road hauliers, but not eliminating it, should be possible as soon as the present atmosphere is improved, as we hope it will be, by our recommendations. So far as we as individuals engaged in transport administration are concerned, we should certainly be glad to do all in our power to assist such collaboration with the advantage of the relations which have developed between us as our discussion continued." May we venture to say that we regard that expression of good will and desire to co-operate between the four 'General Managers of our railways and the representatives of road transport interests as an issue in itself which would have made the Conference invaluable even if no recommendations had resulted. The fact that the Conference was able to agree upon a basis for an equitable division of the burden which should be borne by the road and the rail calls for the warmest congratulations, but even the best-devised principles would come to nought if the desire to apply them in a whole-hearted spirit were lacking. We have no doubt at all that criticism will be directed against some of the conclusions and recommendations of the Conference, but we are equally certain that it has engendered a spirit of co-operation, and to that spirit we look with the brightest hopes to the adoption of means that will give the country the best of both services—the road and the rail.

Literature.

Reports Presented at the First International Congress for Concrete and Reinforced Concrete, Liége, 1930. Liége: *La Technique des Travaux*, 196, Rue Grétry. Second edition. 1932. Price 80 Belgas.

Though issued as a single publication, this report is in two volumes, which may, perhaps, be in separate demand from booksellers. The first contains the complete table of contents, an account of the constitution and proceedings of the Congress, and in the remaining 500 pages the "reports" and summaries thereof in Section I., relating to the four subjects:—Hooped Concrete; Theoretical and Experimental Study, especially of Slabs, Roofs, and Cupolas of Large Span; Large Works; Contraction and Thermal Changes, and Adequate Provision therefor. The second volume, about 400 pages, with the related part of the table of contents repeated, contains the reports and summaries in Section II., relating to Architecture in Concrete and Reinforced Concrete; the Composition, Preparation, and Handling of Concrete and Reinforced Concrete and Control thereof; Pre-cast Concrete (Pipes, Piles, Sleepers, &c.); the Employment of Concrete and Reinforced Concrete in the Colonies.

The languages of the Congress were French, German, and English, the individual papers, or "reports," being published each in one language only, as chosen by the "reporter," but summaries, each usually a third of a page in length, are given in all three languages for every paper. The reports-general, one for each of the eight subjects, officially terme "questions," in the German and English texts, are in French. British engineers may find it useful to know that the numbers of papers in French, German, and English, respectively, are, in Vol. and Section I., 39, 10, and 8; in Vol. and Section II., 31, 7, and 7.

In spite of the object lessons so liberally afforded by past congresses in regard to the importance of employing translators into whose mother tongue the translations are made, the organisers of the Liége gathering largely entrusted the preparation of the summaries in English to other than English translators. The results, not seldom amusing, are often distressing and sometimes misleading. Though suitably so designated in the preface, hooped concrete is, elsewhere, called "bonded concrete." *Séances de travail* is rendered "meeting works," and the French and German terms meaning "of high quality" are represented by "with maximum properties." In one case, however, the translator may have contributed to British technical terminology with the expression "neutral workman," the meaning of which engineers will easily guess; but guessing might fail to suggest that "the jutting in the foundation and side walls" of a dam means "the foundations and the flank abutments," or that a problem made to seem one of the "delayed" characters of deterioration of concrete is really one of the deterioration itself, characterised as slow or gradual, in the French and German texts.

In respect of the theory and data of the subject a considerable number of the papers give expression to fresh views, based upon mathematical studies or experimental research, including important tests to destruction of full-size elements of structures. The descriptions of construction methods furnish much useful information, especially in regard to large-span roofs and domes, and arch bridges; but few of the methods described may widely affect construction generally unless it be that of lightly reinforced retaining walls, to which Mr. E. S. Andrews' short but interesting paper relates, or that of producing cellular concrete, described in a paper by Mr. E. V. Meyer, this material having specific gravities 0·7 to 1·1, where strength is required, or, for insulation work, 0·3 to 0·4. In a paper presenting a method of calculating the stresses in mass dams, Mr. S. D. Carothers adopts, in regard to the insufficiency of the assumptions on which the usual graphic method is based, the attitude of Professor Karl Pearson, about a quarter of a century ago, since when none of the studies made has led to any substantial modification of cross sections as found by the graphic method.

The method of solving problems in statics by means of models is described, in its application to roofs and domes, by Mr. J. Blazek, who prefers Beggs' method to others which he also discusses, namely:—Exact reproduction on a reduced scale, the photo-elastic method, and the Nupubest and continostat methods. An interesting paper, by Dr. F. Kann, relates to a method which he has devised for the experimental solution of the forces in frames. He uses a model constructed of bars of celluloid with joints of hardwood. The principle, that of exaggerated strain, is the same as that applied to the study of stresses in dams by Ottley and Brightmore in 1908. The micro-influentiometer is described, with a number of diagrams and tables of results, by its inventor, Mr. G. Magnel. In a paper on "Allowable Tensile Stresses" Dr. M. Ros gives reasons for the adoption of 10 to 1 as the relation between E for steel and E for concrete.

Of the many papers on large works, mention can only be made of a few which discuss some notable feature or new aspect of design or construction. Mr. C. C. Fishburn describes the dispositions made for test measurements of strains in the arch spans of the Arlington Memorial Bridge at Washington and presents some of the data already obtained. In other papers there are illustrations and descriptions of recently built bridges at Reading, Caversham, and Berwick; Plougastel, described by Mr. E. Freyssinet; Lorraine and Valtschiel; Brussels; Liége; Oswiecim and Lowicz; and Torre Montalvo and Saint-Girons, described by Professor J. E. Ribera. A paper by Mr. B. Plebinski is devoted to a well-illustrated description of the Pont Prince Josef Poniatowski, the great Vistula bridge at Warsaw.

As bearing upon the probable life of reinforced concrete bridges, a paper by Professor L. Santarella is of special interest, the results of the recent test described showing that arch railway underbridges of 27 m. span built in 1904 gave deflections much less than those computed by theory.

Of the papers relating to roofs and cupolas one of the most interesting is that of Mr. L. Baes and Mr. J. Verdeyen, in which parabolic hangars are described and a series of diagrams illustrating wind effects given. Another paper, by Mr. A. Peña Boeuf, is a short description of the Seville hangar, 280 m. in length, 58 m. in height, and 120 m. wide at the base, built to accommodate two Zeppelins, the form of the span being a normal catenary.

The Report, Vol. II., is a mine of information as to the employment of reinforced concrete for large buildings, but in that connection the Congress is likely to be especially remembered for the philosophical contribution of Professor Bereaford Pite on "The Architecture of Concrete." He concludes, negatively:—That we have found no instinctive guidance towards an unbiassed and fresh originality in the æsthetic treatment of both a novel building material and principles of unusual application. That invocations of good proportion or of other abstract principles, though useful as weapons of criticism, are of no assistance in creating a system of design. That superficial colour treatments are insufficient for architectural expression, though valuable in assisting æsthetic effect. Positively: That the texture of concrete surfaces modifies and imparts special character to any forms employed for architectural purposes.

The papers on works in Colonies, relating chiefly to tropical lands, furnish some detailed information as to experience with cements and concretes. Mr. C. Volterbeek concludes that, in the Tropics, high degrees of water-tightness and density are especially desirable and that very great care is necessary in the preparation of the concrete. In a report relating to the use of super-cements on works of the State Railways in the Dutch East Indies, Mr. P. A. Jellema states that French, German, and British rapid-hardening cements having been tried and systematically tested, in no case were the strengths claimed for them obtained. This information is given in the summaries, in which, however, it is not added, as in the paper itself, that British cement, imported directly from England, gave much better results than did those of France or Germany. He found, as have British engineers in India and elsewhere in the Tropics, that the loss of strength during storage was very rapid. It may be noted that, while the term for "rapid-hardening," in the paper, is correctly so rendered in the summary in English, it is, in the French and German summaries, rendered by terms meaning "quick-setting."

The volumes are excellently printed in large type, while the good quality of the paper, the large pages, 12¾in. by 9½in., and a considerable number of folding plates, have provided for the suitable reproduction of photographs, diagrams, and drawings, with which many of the papers are liberally illustrated. As bearing upon postage, it may be noted that the weights are:—Vol. I., 4 lb. 14½ oz.; Vol. II., 3 lb. 7 oz.

Of the many engineering congresses which have been held in recent years, few, if any, can have furnished so much matter of practical value to those concerned, so little that may be passed over by any given proportion of such persons, or so good an example of team work.

BOOKS RECEIVED.

Practical Cable Jointing. London: W. T. Henley's Telegraph Works Company, Ltd., Holborn-viaduct, E.C. 1. Price 5s. net.

Symposium on Rubber. Philadelphia: American Society for Testing Materials, 1315, Spruce-street. Price 1·75 dollar net.

Gas Starter Systems for Aero Engines. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. net.

Dieselmotoren in der Elektrizitätswirtschaft. By M. Gercke. Berlin: Julius Springer, Linkstrasse 23–24, W. 9. Price 6 marks net.

Graphical Geometry. By E. N. Digweed. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 4s. 6d. net.

Wirtschuftlicher Konstruieren-billiger giessen! By Ob.-Ing. R. Lehmann. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse, N.W. 7. Price 4·20 marks.

British Engineers' Association Classified Handbook of Members and their Manufactures, 1932. London: British Engineers' Association, 32, Victoria-street, S.W. 1.

Technical Data on Fuel. Third edition. Edited by H. M. Spiers. London: British National Committee, World Power Conference, 63, Lincoln's Inn-fields, W.C. 2. Price 12s. 6d. net.

Physics: Fundamental Laws and Principles with Problems and Worked Solutions. By Edgar Booth, M.Sc., &c., and Phyllis M. Nicol, M.Sc. Sydney: Australasian Medical Publishing Company, Ltd., Seamer-street, Glebe, N.S.W.

Birmingham Bureau of Research on Russian Economic Conditions. Memorandum No. 6: Wages of Industrial Workers in the U.S.S.R. Birmingham: The University, Edmund-street. Price 10s. 6d. the series of four memoranda.

Recent Advances in Atomic Physics. Vol. I.: Atoms, Molecules and Electrons. Vol. II.: Quantum Theory. By Gaetano Castelfranchi. Translated by W. A. Stiles, Ph.D., and J. W. T. Walsh, M.A., D.Sc. London: J. and A. Churchill, 40, Gloucester-place, W. 1. Price 15s. net per volume.

Cavitation.

By G. S. BAKER.

No. I.

STRICTLY speaking, the word "cavitation" should be applied only to the formation of cavities on propellers. But the term has been used to cover any phenomenon which shows itself in several different ways—by the propeller absorbing power at an abnormal rate after a certain speed has been reached; by a rapid growth in slip and decrease in efficiency above this speed; and by erosion of the propeller blades. But the performance of a ship may deteriorate above a certain speed from several different causes apart from cavitation, and these require some consideration.

A large increase in power may be due to a resistful hull. This becomes apparent in the wave-making and by a marked rise in the ship "C" curve. When this is the sole cause of failure, there is no erosion of the blades.

Failure may also be caused by a *too variable wake*. If the lateral variation of the wake velocity is large and rapid, it is quite possible to have a satisfactory mean slip for the whole screw, and yet parts of the blades in some positions have such a small slip, and other parts in other positions have such a high slip, that the thrust and efficiency break down in both places, but from these very different causes. An approximate idea of the acceptable variation of the wake can be obtained from the equation of efficiency—

$$\eta_i = \frac{1-a_T}{1+a_t}\left[\frac{\tan\varphi_2}{\tan(\varphi_2+\beta)}\right]$$

by considering only the bracketted term, which depends upon the blade action. In this, φ_2 is the angle of advance of the blade through the water, and tan β is the ratio drift/lift for the blade section at its slip angle, which will vary with the wake percentage.

Sections of the screw B_5 in the paper read at the Institution of Naval Architects this spring, taken at the blade root and at 0·83 radius have been examined.

Low slip breakdown will occur at some parts of the blades:—

(1) Propeller at average slip 20 per cent., if the wake varies down to 75 per cent. of its mean value, for all reasonable wakes.

(2) Propeller at average slip 30 per cent. With a mean wake percentage of 0·5 to 0·6, if the wake at boss or blade tip in any position falls below 0·25. With a mean wake below 0·4, it is not likely to occur.

Breakdown due to excessive slip will occur at the tips:—

(1) With a mean wake of 0·3, if the wake in some position exceeds 0·5.

(2) With a mean wake of 0·6, if the wake in some position exceeds 0·8.

But at the root of the blades it will occur:—

(3) At 30 per cent. slip with mean wake 0·3, if the wake in any position rises above 0·55; at 40 per cent. slip with a mean wake 0·3 if the wake rises above 0·35; with a mean wake 0·4 if the wake rises above 0·50.

Satisfactory results may be obtained at low speeds, but when the speed is raised sufficiently to cause wave-making at the stern, the wake distribution changes and breakdown of this kind becomes feasible. It shows by a fairly marked rise in slip, and may occur at quite low values of thrust per unit area of the blade surface. There is some evidence that with sharp-edged sections low slip breakdown will cause erosion on the blade face.

Only twin and multiple screws work at slips so low as 20 per cent. and the obvious course is to keep the blades as far removed from hull and bossings as it is possible, and so avoid the worst wake variation. For high slips the cure still lies in high clearance, but also in the use of low camber ratio sections at the root of the blades, in order to avoid the breakdown of "lift" at small angles. Shape of hull, of course, affects the wake distribution, but this must be left apart.

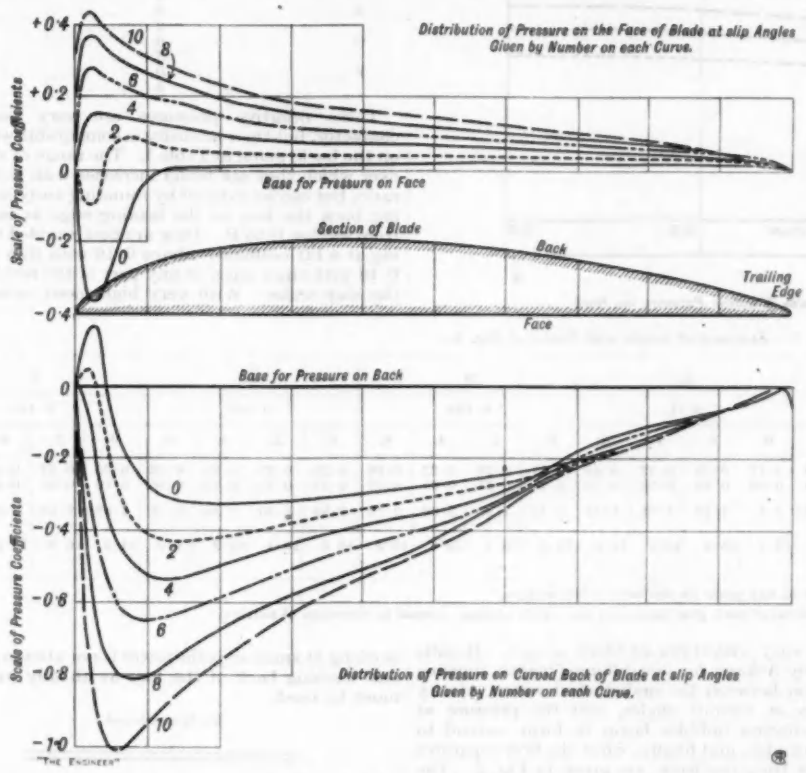

FIG. 1—*Pressure Distribution over Propeller Blade Section at Small Angles of Slip. The Total Pressure is the Sum of the Positive Pressure on the Face and the Suction or Negative Pressure on the Back.*

Cavitation proper may be brought about by either:

(1) Entry of air into the screw from the surface; or

(2) Absorbed air released from the water in front of the screw; or

(3) The local negative pressure on some part of the blade approaching the vapour pressure of water and consequent formation of vapour; or

(4) The fall of pressure at any point being equal to the total potential head of water and atmosphere.

In (3) and (4) the flow parts from the blade, leaving a low pressure region between blade and flowing water. Bubbles of air or vapour are then released on the blade surface and swept away. The edge of the cavity is very unstable in position, and the pressure change from the cavity to water side of it is very great. This varying impact of the streaming water at the rear of the cavity causes erosion, and this is assisted by the collapse of the vapour bubbles mentioned, when these approach the end of the cavity sheet. If air enters the screw from the surface, much the same thing takes place. If in large quantities, the air adheres to the blade, distorts the flow, but is gradually swept away as the blade moves downward (usually, as an "emulsion" formed during the rapid unstable changes), as the normal "solid water" regime re-establishes itself. Almost invariably erosion due to this will show itself over an area from the tips inwards, whereas erosion due to release of air in the blade or to obstructed flow shows as a circumferential pencil or series of patches.

Each propeller blade as it advances through the water is accompanied by a pressure system appropriate to the blade sections, the slip angle and velocity. The general characteristics of these pressure curves are the same for all blades. Typical curves are given in Fig. 1, for the aerofoil shown at several angles. The ordinates of the curves are absolute pressure constants, *i.e.*, are expressed in terms of the static pressure equivalent to the velocity of the section. For units of pound-foot and foot per second the pressure in salt water is equal to ordinate × 1·99 v^2.

Results at small slip angles only are shown. At large slips (above about 16 deg. on good sections, and 10 deg. on others), the negative pressure constant all over the back is the same (about 0·33), whatever blade section is used. In this last condition the flow over the back has broken down completely, and if it is reached by a propeller the efficiency would be bad, and erosion would be only a minor evil. Attention therefore need be centred only on the small angles. For any positive slip angle there is positive pressure on the driving face, shown above the base line, and negative pressure on the back, shown below the base. The sum of the areas contained under the two curves, gives the total pressure on the blade normal to its path. At all working angles the major portion of the thrust is due to the negative pressure on the back. Also these negative pressures are very large near the leading edge compared with the mean pressure, and it is these which must be watched when cavitation is possible.

For the section shown in Fig. 1, the ratio of maximum intensity of negative pressure on the back (p_m) to the mean normal pressure (k_L) on the section, varies from 1·4 to 1·5. This ratio varies with type of section, but the figure is roughly representative. If every part of a propeller blade moved through water at the same velocity, this would represent the whole variation on the blade, but the velocity increases towards the tip, an effect partially balanced by the diminution of camber ratio and by tip losses. In addition to this variation there is the variation due to the wake. Calculations made for a screw at an average slip of 30 per cent. in a ship wake varying from a maximum velocity of 0·5 the ship velocity at the blade tip, when nearest to the hull, to nil when the blade tip was at the outer position, showed that the maximum pressure on a strip of the blade exceeds the *average value for the blade over a revolution* by some 78 per cent., and for over 45 per cent. of a revolution the pressure over the area between 0·6 and 0·9 the radius, exceeds the mean for the whole blade by 33 per cent. In this case, therefore, the ratio of maximum intensity negative pressure (p_m) to mean pressure over the whole propeller is roughly 1·4 × 1·33 = 1·86 over about 45 per cent. of a revolution. The designer's aim is to keep down this ratio by avoiding high and variable wake conditions, and by using blade sections which have no peak of high intensity negative pressure on the back.

In all propeller calculations it is assumed that: (1) The screw is working in a fluid of uniform density,

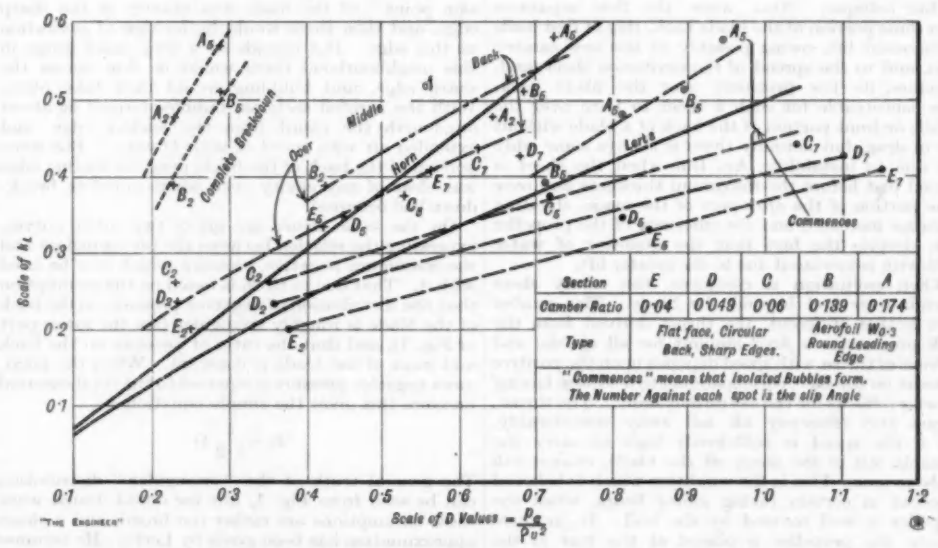
Scale of k_L
0·6
0·5
0·4
0·3
0·2
0·1
Complete Breakdown
Over
Middle
Horn
Back
Lens
Commences
Section | E | D | C | B | A
Camber Ratio | 0·04 | 0·049 | 0·06 | 0·139 | 0·174
Type | Flat face, Circular Back, Sharp Edges. | | | Aerofoil W.G.-3 Round Leading Edge | |
"Commences" means that Isolated Bubbles form. The Number Against each spot is the slip Angle
0·1 0·2 0·3 0·4 0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2
Scale of D Values = $\frac{p_s}{\rho v^2}$
"THE ENGINEER"

FIG. 2—*Relation Between Lift Coefficient k_L for Cavitation and the Total Superincumbent Pressure (p_s).*

and (2) that there is sufficient energy in the water particles to enable them to give up the necessary "head" equivalent to the induced negative pressures on the blades. The potential head available is the total static head, and the maximum induced velocity in the water (or the equivalent negative pressure) must be kept below this. But just before this condition is reached, the pressure will be sufficiently low (0·25 lb. to 0·5 lb. per square inch) for vapour to form at ordinary temperatures. Bubbles then form in the water, at first singly, beginning apparently at pressures some six times the vapour pressure. These become more frequent as the loading is increased, and the next stage is a definite separation of the flow over the worst affected area, with bubbling proceeding rapidly at the edges of the sheet of separation and underneath it. This condition is what is often called pure cavitation.

Experiments with blade sections in a uniform stream of water have shown that the mere *formation* of these bubbles does not alter the lift and drift of the sections, and this form of cavitation can proceed without change of efficiency until the surface of the propeller has been roughened by erosion due to bubble collapse. Also, when the flow separates from some portion of the blade back, this at first leads to *increased* lift, owing possibly to the new camber ratio, and to the spread of the cavitation sheet (and, therefore, its low pressure) over the blade back. It is conceivable for such a sheet to form over the middle or front portion of the back of a blade without loss in drag, but actually there is always some eddy loss due to instability, &c. But when the sheet is formed just before the maximum thickness and over some portion of the *after* part of the blade, the drag is *always* increased and the efficiency of the propeller falls, despite the fact that the quantity of water dealt with is increased due to the greater lift.

When cavitation is complete, the cavity sheet extends over and beyond the blade. The camber ratio is then different, the thrust derived from the back pressure is a *fixed* amount for all speeds, and increase of thrust with speed depends upon the positive pressure on the face, corresponding to a section having a back profile as for the cavitation sheet. The thrust, torque and efficiency all fall away considerably, but if the speed is sufficiently high to carry the unstable tail of the sheet off the blade, *erosion will not be serious*. This is the condition which is believed to occur in certain racing motor boats, when the propeller is well covered by the hull. If, in these vessels, the propeller is placed at the rear of the transom, then air is admitted to the screw, the pressure on the blade back becomes atmospheric instead of the vapour pressure, and the thrust must be wholly derived from the face.

For all practical purposes, the vapour pressure may be taken as zero, and the condition for cavitation to be developed on the blade back will be given by :

$$p_a = \frac{v_m^2 - v_t^2}{2\rho}$$

where v_m is the induced velocity at any point of the blade ;

v_t the velocity through space of this point,

and p_a is the total pressure head.

Putting $v_m = \alpha\, v_t$ and $\frac{v_t^2}{2\rho} = q$ = static pressure corresponding to v_t, this becomes

$$p_a = q\,D, \text{ where } D = (\alpha^2 - 1) \quad . \quad . \quad (1)$$

This equation gives the condition for complete breakdown. Ackeret has shown experimentally that there is a considerable pressure range between that for incipient cavitation, i.e., when vapour bubbles just form locally, when a local cavity forms, and when the sheet and stream of bubbles disturb the flow over the whole back. These pressure conditions will vary with different blade section. Results obtained by Ackeret for five different blades, showing the relation between the undisturbed water velocity past them at various angles, and the pressure at which cavitation bubbles begin to form, extend to the trailing edge, and finally, when the flow separates completely from the back, are given in Fig. 2. The diagram gives the value of the lift or pressure coefficient of the blades when each phase of cavitation occurs, to a base of the D value of equation (1). Sections C, D, E had normal circular backs, and cavitation always showed first at the sharp leading edge, as it should in theory at all speeds, and the actual "commencement" was not so definite as with the rounded leading edge of the two aerofoil sections A and B. For these sharp edged sections there would be a particular angle of attack at which the "stagnation point" of the blade was exactly at the sharp edge, and then there would be no sign of cavitation at this edge. But outside of a very small range in this neighbourhood there would be flow across the sharp edge, and bubbling would then take place. With the aerofoil sections, bubbles formed at about one-fourth the chord from the leading edge, and extended aft with speed or with D value. But some portion of the back of the blade near the leading edge was clear of any cavity even when complete breakdown had occurred.

On the same figure are given two other curves, expressing the relation between the lift coefficient and the maximum negative pressure which can be used with it. That due to Horn is based on the assumption that the distribution of negative pressure on the back of the blade is roughly triangular (see the lower part of Fig. 1), and that the ratio of pressure on the back and front of the blade is constant. When the maximum negative pressure is equated to the total external pressure this gives the simple equation :—

$$k_L = \frac{1}{1 \cdot 3}\,D$$

The general truth of the "triangular" distribution can be seen from Fig. 1, but for detail design work these assumptions are rather too broad, and a closer approximation has been given by Lerbs. He assumes that for any blade section there can be substituted a circular back section, having such a thickness as to give the same lift coefficient, and that the greatest negative pressure on the circular back section and the original section will then be reasonably the same. The change of pressure over a circular back is calculable in terms of velocity, and the limiting condition for cavitation becomes

$$k_L = \frac{\pi}{6}\left[\sqrt{3\,D+1} - 1\right]$$

where D is defined as before. Lerbs expressly confines this method to sections working with lift coefficients above 0·15, as the influence of shape of section at low values renders the initial assumptions untenable.

So far consideration has been confined to the breakdown of flow over the back of the blade. But if the slip angle is small, relatively high negative pressures are developed on the driving face quite close to the leading edge. These can be seen for the section on Fig. 1. For the sections K, M, N, O, P of Fig. 3 the negative pressure constants on the face at angles between 0 deg. and 2·0 deg. reach values given in Table II.

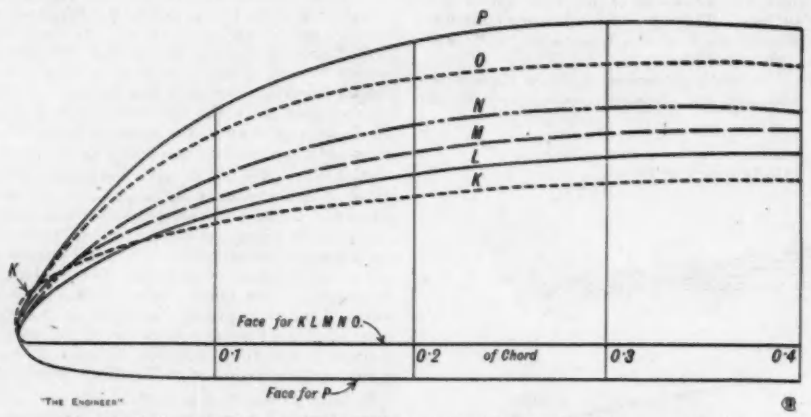

Fig. 3—*Sections of Blades at Leading Edge and Maximum Negative Pressure on Back.*

Table II.—*Negative Pressures on the Driving Face Sections, Fig. 3.*

Section.	Slip angle.	Max. negative press. constant.
K	0	0·37
	2	0
M	0	0·37
	2	0·15
N	0	0·42
	2	0·10
O	0	0·42
	2	0·26
P	0	0·42
	2	0·05

These negative pressures are very peaked in character, but their intensity is comparable with those on the back, given in Table I. The range of slip angle over which they are found increases with the camber ratio, but can be reduced by rounding away and washing back the face at the leading edge as in passing from section O to P. They are best avoided by working at a lift coefficient above 0·16 with thin sections, 0·18 with thick ones, at any part of the revolution in the ship wake. With very high-speed motor boats working at small slips the latter is not always possible, and washing back of the face as already mentioned must be used.

(To be continued.)

Table I.—*Summary of Results with Blades of Fig. 3.*

Section	K.				L.				M.				N.				O.				P.			
Camber ratio	0·09.				0·10.				0·11.				0·125.				0·145.				0·187.			
Slip angle	0.	2.	4.	6.	0.	2.	4.	6.	0.	2.	4.	6.	0.	2.	4.	6.	0.	2.	4.	6.	0.	2.	4.	6.
k_L	0·147	0·22	0·29	0·36	0·17	0·25	0·32	0·40	0·17	0·25	0·32	0·40	0·17	0·24	0·32	0·40	0·20	0·28	0·35	0·43	0·23	0·32	0·41	0·47
p_m	0·30	0·37	0·60	0·90	0·32	0·41	0·54	0·65	0·36	0·45	0·55	0·70	0·44	0·54	0·64	0·87	0·57	0·70	0·79	0·95	0·70	0·81	0·92	0·99
$\frac{p_m}{k_L}$	2·05	1·68	2·04	2·46	1·85	1·64	1·68	1·62	2·1	1·80	1·71	1·75	2·53	2·25	2·00	2·15	2·85	2·50	2·26	2·21	3·08	2·50	2·24	2·11
$\frac{k_L}{k_D}$	13·1	18·2	19·5	18·2	13·1	17·3	18·5	17·3	12·1	16·6	18·0	17·0	11·3	15·1	16·6	16·3	10·6	14·1	15·2	14·9	14·5	16·0	15·2	13·9

p_m is the maximum negative pressure at any point on the *back* of the section.

k_L is the mean value of the pressure (total of back plus face) over the whole section, normal to direction of motion.

Converted Marine Steam Engine.

The statement often made that many older cargo vessels are over-engined is supported by the fact that Alex. Stephen and Sons, Ltd., of Linthouse, Glasgow, have just converted an 1800 I.H.P. triple-expansion engine, made by them some years ago, for the coaster s.s. "Annan," to provide a more economic unit for developing the maximum 900 H.P., which is sufficient in practice.

Originally, the machinery of s.s. "Annan"—owned by Wm. Sloan and Co., Glasgow—consisted of a single triple-expansion engine, having cylinders 22½in., 35in., and 59in. in diameter, with 42in. stroke, to which steam was supplied by two three-furnace Scotch boilers, 14ft. 3in. in diameter and 11ft. 6in. in length, working under natural draught at a steam pressure of 165 lb. per square inch. The whole of the machinery was twenty-five years old, and, as the boilers required renewal, they have been replaced by a pair of two-furnace Scotch boilers, 12ft. 6in. in diameter and 11ft. 6in. in length, made by Alex. Stephen and Sons, Ltd. These boilers have a working pressure of 200 lb. per square inch, and employ Howden's forced draught, and two-flow tubular air heaters. Smoke-tube superheaters supplied by the Superheater Company, Ltd., have been adopted to give a total superheat of 100 deg. Fah. at the engine stop valve.

The original cast iron condenser, integral with the two after columns, was cracked, and a new cylindrical steel, electrically welded, three-flow condenser has now been mounted on two new cast iron columns. A "Weir" monotype air pump and an Andrews and Cameron surface feed water heater have been fitted, the latter taking the steam from the auxiliary exhaust and some bled from the L.P. receiver.

On the engine itself three new cast iron cylinders having diameters of 16½in., 26½in., and 46in. have been fitted, reducing total power to about 1000 H.P., this being much nearer maximum load conditions at sea and allowing about 100 H.P. margin. From the illustration on page 189, the disposition of the new parts will readily be gathered. Two large volume I.P. and L.P. receivers, formed of steel sheets electrically welded, are seen to separate respectively the H.P. and I.P., I.P. and L.P. cylinders. All the pistons are of cast iron, that of the H.P. being mechanically lubricated through four quills fitted through the liner. Special interest attaches to the L.P. cylinder, this being of the uniflow type, so designed that the piston uncovers the exhaust ports at 9/10 stroke ; whilst the clearance volume allows compression to be taken right up to admission pressure with a vacuum of 26in. Compression release, spring-loaded valves are to be seen mounted on the L.P. cylinder at the extreme left of the illustration. A trap rids the bottom of the cylinder of water.

The other cylinders are fitted with four slide valves, the L.P. having but two. The steam and exhaust valves are independent, and the valve spindles are horizontal. All these valves, supplied by Andrews and Cameron, are of the balanced type, and are operated by slotted cams driven off the existing Stephenson link motion. The cam rods oscillate wrist plates, situated midway between

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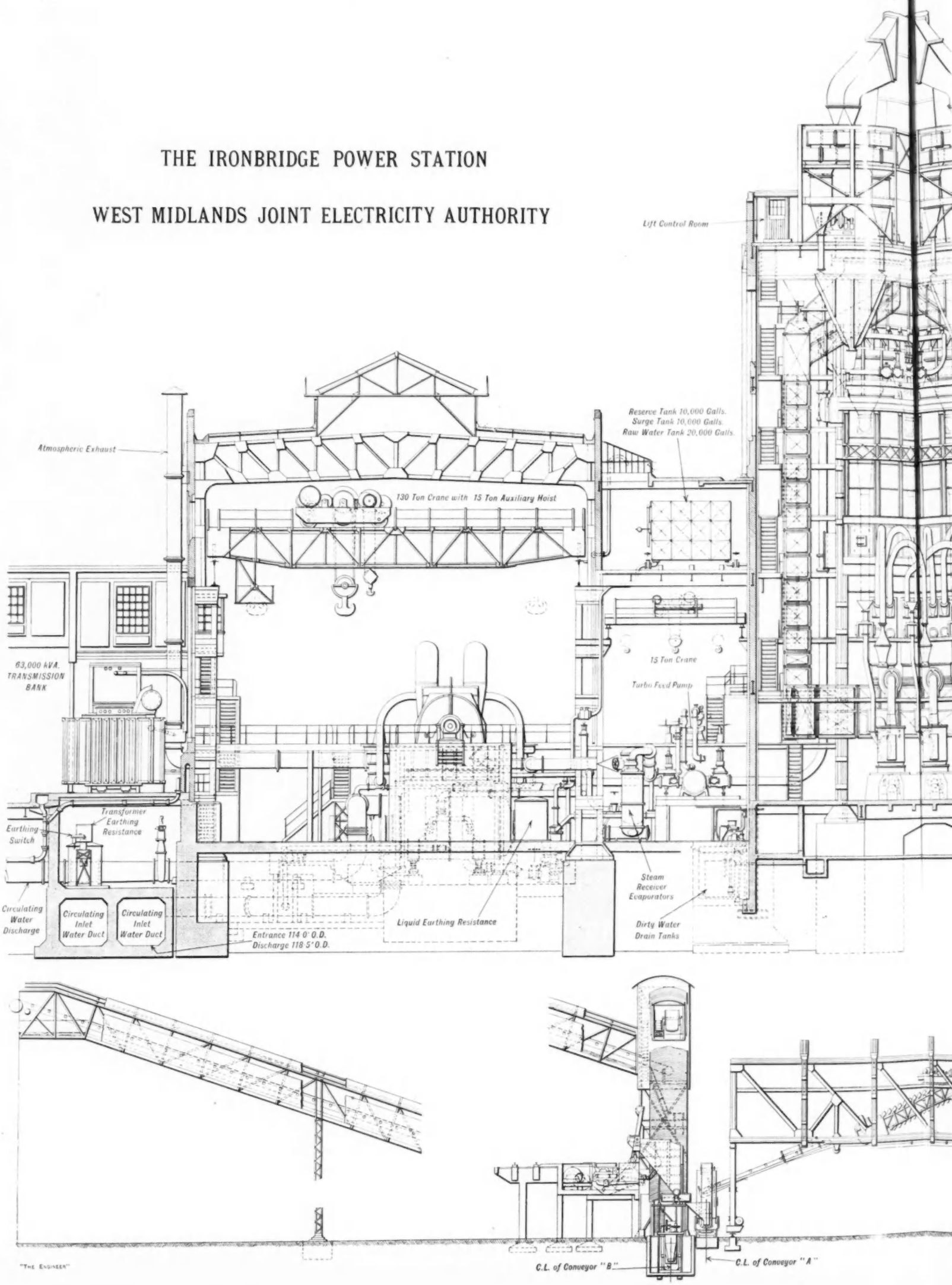
WEST MIDLANDS JOINT ELECTRICITY AUTHORITY



"THE ENGINEER"

3" Steam to Blowers

10" Hot Feed 10" Cold Behind

Economiser Floor

6" Cold

6" Hot

6" Cold Feed

Joins Superheater Header

Cope's Regulator

3/4" Steam

5" dia

3/4" Water

25 - 6" Between Walls
49 Tubes 4" out. dia.

C.L. of Boiler Columns

5" dia

Venturi Meter

1/2" Drain

C.L. of Boiler Columns

Vacuum Breaker

4" Aux. Steam from Steam Receiver

Exhauster Fan Floor

142'0" O.D.

Clean Water Drain Tanks

Oil Fuel Storage Tank

0 5 10 15 20 25 30 35 40 45 50 55 60
Scale Feet

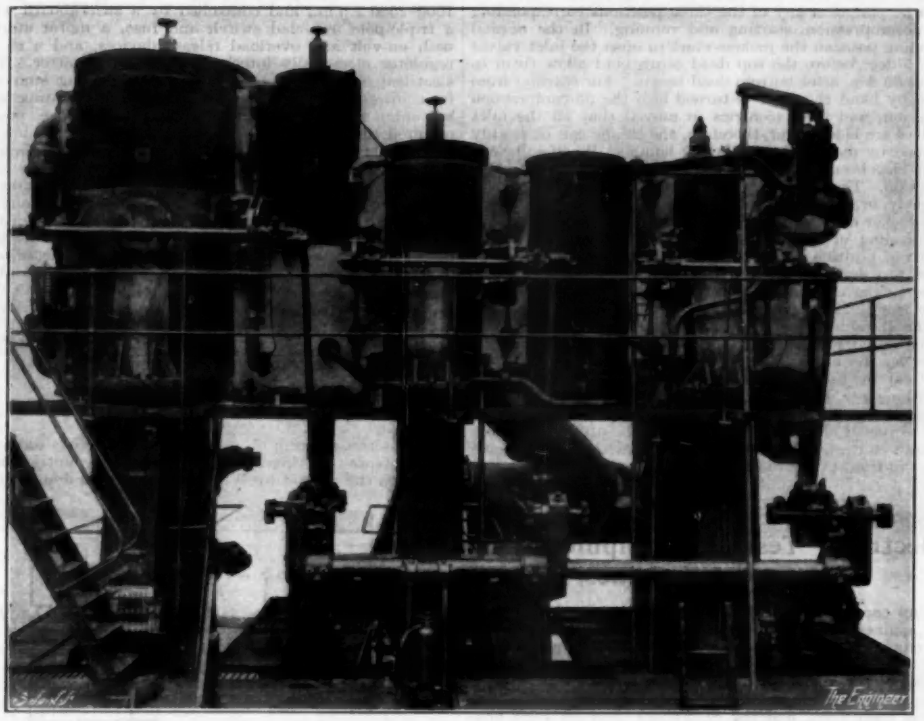
COAL PILE

0 10 20 30 40 50
Scale Feet

UNIV. OF MICH.

CONVERTED MARINE STEAM ENGINE

ALEX. STEPHEN AND SONS, LTD., LINTHOUSE, ENGINEERS



the top and bottom valves, which, in turn, operate the spindles through bell crank levers. The spindles, of case-hardened steel toughened by heat treatment, are pressure lubricated and pass through ground and lapped cast iron bushes. The H.P. and I.P. valves have a maximum travel of 1·77in., and the L.P. valves, which are double ported, a travel of 1·8in.

As reconstructed, the engine is designed to work with a condenser vacuum of 27in. and a pressure drop between the L.P. cylinder and the condenser of only 1 lb. With the engine developing 900 I.H.P. and a cut-off in the H.P. cylinder of 55 per cent., the expansion ratio is 1 : 14.

At the time of our visit the engine ran smoothly under the following conditions:—H.P. steam, 175 lb.; I.P. receiver, 45 lb.; L.P. receiver, 2 lb.; L.P. exhaust, 23in. vacuum, the main condenser being short of water.

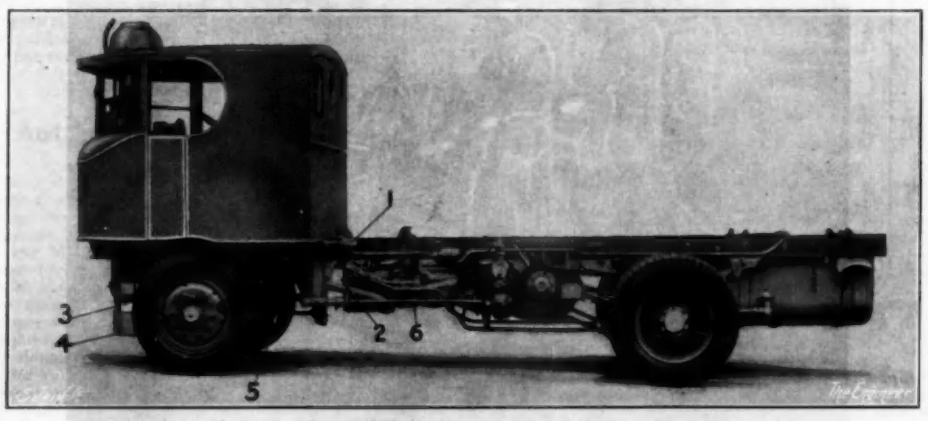
We were informed that it is proposed to test further a method of operating all the slide valves by means of a 400 lb. pressure oil system employing a rotary valve to control the steam cut-off.

The One-Man "Sentinel" Steam Wagon.

In the Road Act it is laid down that in cases in which there is only one man in charge of a steam wagon he must stop the vehicle when it is necessary for him to attend to the fire. This disadvantage has been entirely overcome, and a clean driver's cab, with automatic fuel and water control assured, in the new one-man Sentinel wagon, which is equipped with a patented automatic screw-feed "Sentinel" stoker and the Sentinel-Trist thermo-feed regulator.

The coal is carried in a steel hopper with a filling chute at the back of the cab, and a hinged lid at the side of the driver's seat for lighting-up service or emergency use. It carries 6 cwt. of fuel, which, according to operating conditions, is generally sufficient for a journey of 150 to 180 miles. The coal, after passing through a crusher, is fed by the screw through an enclosed casing and passes through openings in the sides, to the boiler and fire-box and on to the rotating grate. An even distribution of fuel over the surface of the grate is obtained, and the damping down of the fire by intermittent charges of fresh unburnt fuel prevented. The rotating fire-grate is mounted in a frame supported on three steel rollers, which are spaced 120 deg. apart, and are protected against the ingress of dirt and furnished with nipples for grease lubrication. The roller at the front of the boiler is carried on a trunnion frame, and is furnished with a handle, so that it can be swung down clear of the grate when it is required to clean the fire.

The boiler feed pump is engine driven, and normally it delivers water at a rate proportional to the engine speed. By fitting the Sentinel-Trist thermo-feed system, however, a supply of feed water proportional to the supply of fuel is obtained. Referring to the accompanying engraving, the feed control valve (1) actuates a lever (2), which controls the fuel mechanism. There is also another lever in the driver's cab which enables the rate of fuel feed to be varied to suit the quality of coal being used and the particular running conditions. The rotating grate is shown at (3), with the ashpan (4) below it, whilst (5) indicates the driving shaft for rotating the firegrate, and (6) the shaft from the engine to the fuel supply mechanism. Although the illustration does not enable us to show it, the new Auto-Sentinel has a neat arrangement of driver's cab, which, with the absence of hand firing, can be easily kept clean.



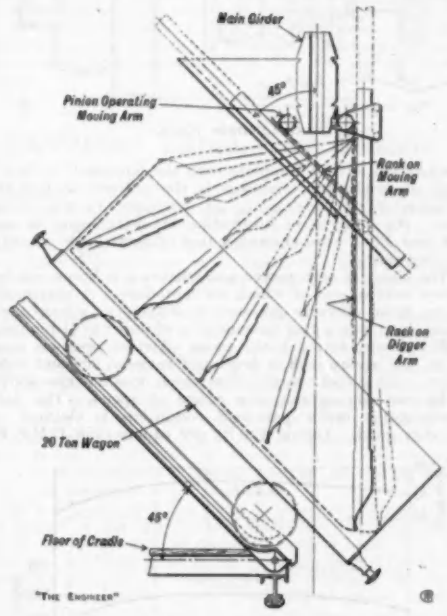
THE AUTO-SENTINEL STEAM WAGON

The Norfolk Spade.

The trimming of wet duff coal out of railway trucks, even when they are well tipped at the staithes, is often a matter of considerable importance, especially in winter time, when the coal is very reluctant to leave the truck, and normally may require the labour of three or four men for perhaps half-an-hour to clear the truck. With the appliance which we illustrate, however, the operation can be effected in a few minutes, even with the most stubborn material, and with the attendance of only one man. The "spade," as it has been called, is the invention of Mr. T. L. Norfolk, the Engineer-in-Chief to the Mersey Docks and Harbour Board, and is manufactured by Vickers-Armstrongs at the Elswick Works, Newcastle-on-Tyne. The first of these spades was put to work in the Canada Dock, Liverpool, while one of the latest is being installed at Leith. Several others have been ordered by the Great Western Railway.

The broad principle of the appliance is to dig out the contents of the truck with a mechanically operated spade. This spade has a telescopic, spring-operated lip, so that it shall not damage the bottom of the truck, and is mounted on a digging arm, which is pivoted to the main frame of the hoist and to another diagonal moving arm. Both arms can be extended by means of racks and pinions operated by two hydraulic motors. By combining the movements of the two arms the spade can be made to dig out the whole of the contents of a truck and to scrape it clean. The controls for the hydraulic motors are arranged in a cabin,

THE NORFOLK SPADE



ACTION OF SPADE

from which the operator has a full view of the working of the spade. The movements of the spade are completely controlled by the manipulation of only two levers.

Dorman-Ricardo Compression Ignition Engines.

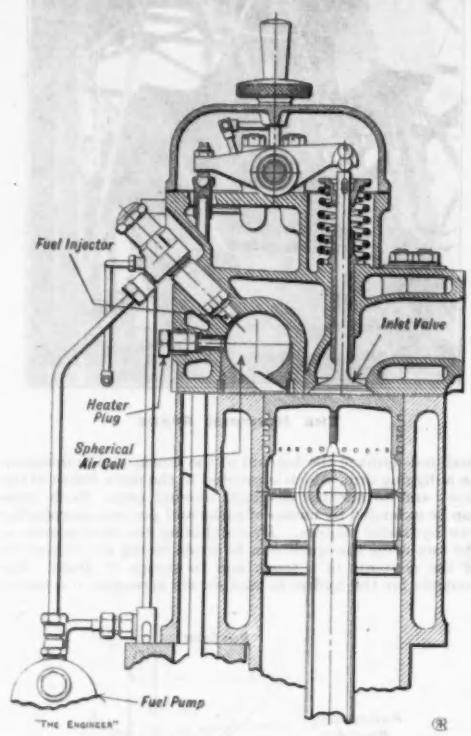
The Ricardo "Comet" type of combustion chamber which is incorporated in all the Dorman compression-ignition engines made at Stafford, has the primary object of obtaining a high power output and efficiency with a clean and odourless exhaust. A further advantage is that it is possible to work at all speeds and loads with a fixed injection, thus the maximum pressure in the cylinder is never under the control of the driver.

Reference to the sectional drawing will show that the combustion chamber is situated at one side of the cylinder head. This chamber consists essentially of a recess formed in the head which constitutes the upper part of the chamber, the lower portion being formed by a plug secured by a ring nut. This plug is provided with a tangential passage communicating with the main cylinder.

The condition of fixed injection timing is obtained, as explained by the makers, in the following manner:—(*a*) The speed of rotation of the air in the combustion chamber increases proportionally with that of the engine, and there is little dependence on the velocity of the fuel stream. (*b*) The bowl-shaped lower chamber is secured to the cylinder head as shown on the sectional drawing. On the outer side of this part an air gap or clearance is provided at both the top and the bottom, contact only

being made with the cylinder head and securing nut on the large diameter. This clearance acts as an heat insulator, and as the amount of heat given up to the bowl-shaped body is proportional to the amount of air passing through the tangential passage in a given time it is, therefore, proportional to the engine speed and the amount of heat conducted away is constant as the area for conduction remains the same. Therefore, the temperature of this body increases with the speed, and thus has the effect of decreasing the delay period during combustion and accelerating that process in proportion to the speed.

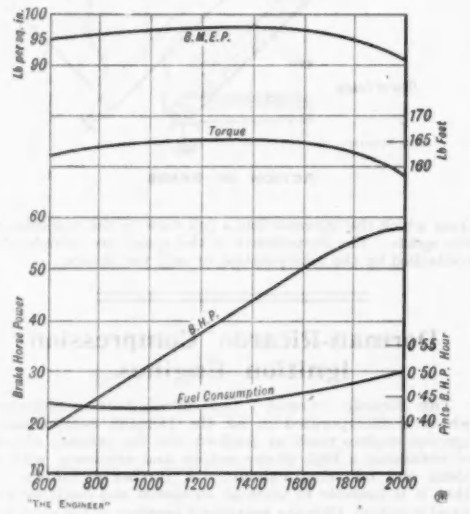
A clear exhaust is obtained on account of the complete combustion throughout the speed range, and the heat retained in the bowl-shaped body is sufficient to prevent the formation of aldehydes and, therefore, to eliminate smell in the exhaust. Another factor that indicates that



CYLINDER HEAD

combustion is very complete with the Ricardo "Comet" type of combustion chamber is the absence of fuel oil dilution of the lubricating oil contained in the crank case. An analysis of lubricating oil after being in use for over 1200 miles showed a fuel dilution figure of only 0·5 per cent.

The claim of high power and efficiency is borne out by power curves, one of which we reproduce. A maximum brake mean effective pressure of 102 lb. per square inch is obtained with a fuel consumption of under 0·41 pint per B.H.P. hour, and a brake mean effective pressure over 95 lb. per square inch is developed between 600 and 1350 r.p.m. with a fuel consumption which does not rise above 0·42 pint throughout this range of speed. The fuel consumption under part-load conditions is claimed to be very good. Taking 100 lb. per square inch B.M.E.P.



POWER CURVES

as a full-load figure, the fuel consumption is under 0·41 pint per B.H.P. hour. At 75 lb. B.M.E.P., or three-quarter load, the consumption is 0·38 pint per B.H.P. hour, and at 50 lb. B.M.E.P., or half load, the consumption is 0·42 pint per B.H.P. hour.

A standard type of Bosch fuel pump is used in all cases, and is driven at half engine speed by means of helical gearing. The fuel pump is governed to limit both the maximum and minimum speeds. The injection nozzles are of the Bosch pintle, or self-cleaning, type. The end of the nozzle valve projects through the end of the nozzle body after each injection takes place, and, therefore, effectively clears away any carbon, &c., that may have formed round the nozzle body. This type of nozzle has a single large 2 mm. diameter hole and a 30 deg. spray angle. The injection pressure is moderate, being set at about 1500 lb. per square inch.

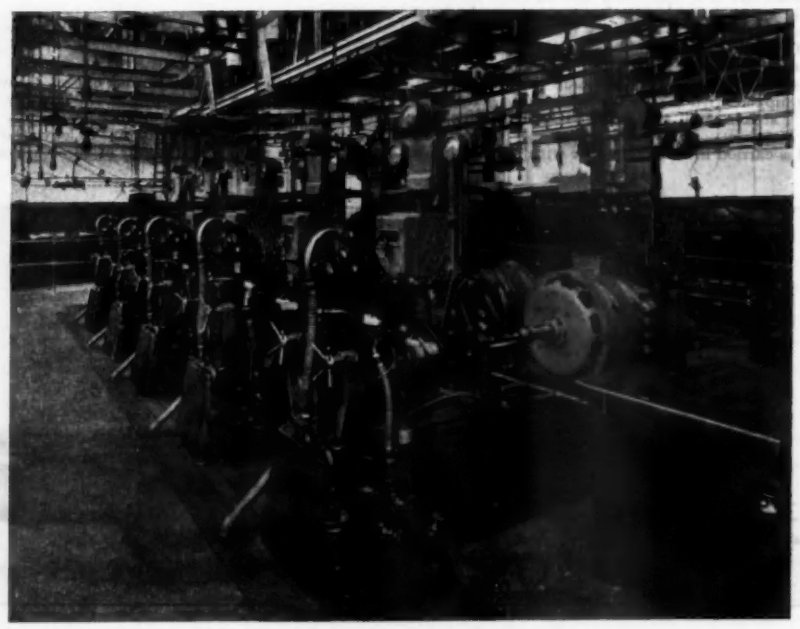
Starting is in all cases by hand, and is arranged as follows. The inlet valves are pivoted on excentrics formed integral with the rockers. By means of handles placed at the front and rear of the engine, the excentrics can be placed in any of the three positions corresponding to decompression, starting and running. In the normal running position the rockers start to open the inlet valves at 15 deg. before the top dead centre and allow them to close 30 deg. after bottom dead centre. For starting from cold by hand the lever is turned into the no-compression position, and the excentrics so moved that all the inlet valves are held open; therefore, the engine can be readily turned by means of the starting handle. When sufficient speed has been attained the lever is moved into the starting position. The excentrics then raise the inlet valve rockers slightly, or, in other words, increase the clearance between the rocker and the valve stem and thus reduce the period of opening of the inlet valves. With the lever in the starting position the actual valve timing is open 5 deg. past top dead centre and close at bottom dead centre. This timing enables a greater volume of air to be drawn into the cylinder at the speeds obtaining when cranking by hand, and, therefore, enables the compression pressure to be raised sufficiently to ensure starting from cold. As soon as the engine fires the levers are turned into the vertical or normal running position. The three lever positions are located by the means of a spring-loaded plunger engaging with flats milled on an enlarged portion of the rocker shaft. The handles can be arranged to suit remote control, which can be carried to some convenient place in front of the radiator if desired.

Electrical Testing Equipment for Motor Car Engines.

THE care which is taken to ensure that modern motor car engines are in perfect working order and capable of developing their full rated power is well exemplified by the testing plant which has been installed in the Coventry works of the Humber-Hillman Motor Car Company, Ltd. Hundreds of Hillman "Minx" cars are completed at the works each week, and the equipment used for their production is of the latest and best kind. Before assembly on its chassis, each power unit, consisting of the engine, clutch, and gear-box, is delivered into the testing department by means of an overhead conveyor, and is placed in the correct position on one of ten test beds by means of compressed air equipment. After the water, oil, and petrol pipes have been connected up, and the engine has been coupled to a 20 horse-power motor, the complete power unit is electrically driven for a period of 15 min., with the ignition switched off, the throttle closed, and the top gear engaged. The ignition is then switched on, and a light load is applied to the engine at a speed of about 1000 r.p.m., by making the motor act as a generator, thus allowing the engine to warm up sufficiently for subsequent heavier loads. Half load is then applied for 15 min., and three-quarter load for 10 min. at 1500 r.p.m., and during these test runs the cylinder head nuts are tightened and the engine is inspected to discover whether there are any oil leaks or other faults.

Full load is then applied at 1500 r.p.m., and the speed is gradually increased to 2500 r.p.m., when every nut on the cylinder head and gear-box is again tightened. During this test of approximately 1½ hours' duration, all moving parts are becoming free in action. Clean oil is circulated through the engine the whole of the time, and the water-cooling tower built on the roof of the test-house is controlled, so that the water leaves the engine at a temperature of 60 deg. Cent. The second gear is then engaged, and the speed of the engine increased to 3000 r.p.m., when the ammeter registering the generator output must show at least 30 ampères. After a short test with the bottom gear in service the engine is stopped, the tappets are adjusted, and a final test is made at 2500 r.p.m., with the top gear in action, when the current output of the generator must be 25 ampères. The engine is then dismantled, cleaned and dispatched by the overhead conveyor to the chassis assembly department.

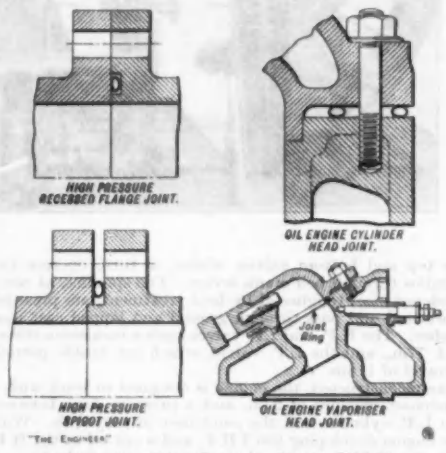
Ten of these electrical testing sets were manufactured and installed by the General Electric Company, of Magnet House, Kingsway, W.C.2. Each set consists of a 17-kW, 460-volt D.C. machine, designed for a speed range of 1000–2500 r.p.m., and controlled by a switchboard with a triple-pole iron-clad switch and fuse, a motor starter with no-volt and overload release devices, and a shunt regulator electrically interlocked with the starter. The electrical instruments consist of a zero-reading ammeter for showing the load when the machine is generating, and an ammeter and voltmeter for indicating the power required to drive the engine electrically. With a view to securing stability, a light counter-compound winding is provided on the poles of the machines, which are also equipped with a mechanical overspeed device for tripping the motor starter and for interrupting the ignition circuit in order to prevent the engine racing in the event of the circuit breaker opening and cutting off the load current that is fed into the line. Each test bed has its own switchboard, with starter, regulator, and instruments, so that the operator has complete control over his own particular testing equipment. A view of the testing sets is given in the accompanying illustration.



MOTOR CAR ENGINE TEST BED

Gas-Filled Joint Rings.

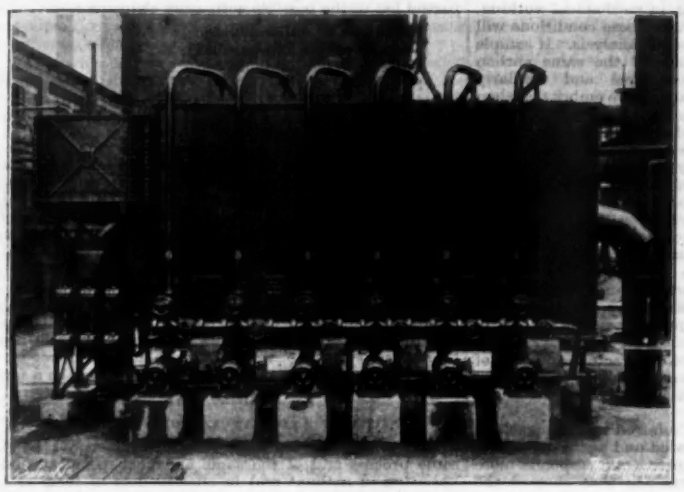
AN interesting form of gas-filled joint ring has recently been patented in Great Britain and other countries and placed on the market by Wills Pressure Filled Joint Ring,



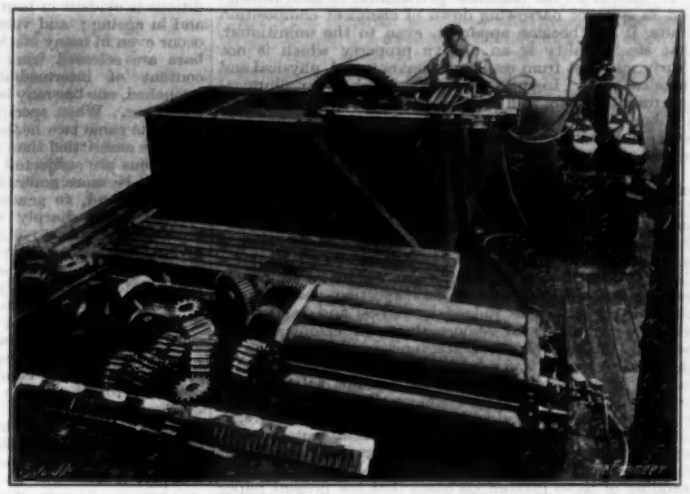
USES OF GAS-FILLED JOINT RINGS

Ltd., of Bridgewater. The rings, a selection of which we were recently invited to examine, are made of tube of circular cross section, with the ends butt-welded together, the enclosed space being filled with inert gas under high pressure. For joints in low-pressure pipe systems up to a pressure of, say, 150 lb. per square inch, a copper tube is employed containing an internal pressure of about 300 lb. per square inch. For higher pressure joints, Monel metal tube is used, with an internal pressure of about 600 lb. per square inch, and with such rings pressures up to 2500 lb. per square inch have, we are informed, been satisfactorily held. During the process of manufacture the internal pressure in the ring is greatly exceeded, under high-temperature conditions, so that for normal temperature conditions a high factor of safety is given. The inert gas within the ring remains, we are told, in a gaseous state over a wide range of temperature and does not liquify until a temperature several degrees below zero Centigrade has been reached. We are further given to understand that in practice no broken tubes or blown

joints have been met with. The accompanying engraving shows four examples of the use of pressure filled rings. Although the rings can be used between plain flanges, the makers draw particular attention to the possibilities of using the pressure filled ring—which is claimed to have a high degree of resilience—in a recess, as shown in the sketches reproduced to the left of the drawing, which enables a tight metal-to-metal joint to be made. No auxiliary jointing compound is required. When under pressure in the pipe line, the gas-filled rings—which are manufactured in ⅛in. and ¼in. diameter material to suit British Standard pipes, Tables 1 and 2, and also special sizes—undergo a reduction in cross section of about one-third of the original diameter of the tube, taking up the elliptical form shown in the drawing. When the pressure on the joint faces is released, they recover about half their deformation, after which the joints can be unmade and remade repeatedly with satisfactory results. They are particularly useful, the makers claim, for high-pressure steam joints and for the cylinder and vaporiser joints used in oil engine practice. The two drawings to the right of our illustration show the use of these rings for the cylinder head and vaporiser joints of a Petter oil engine. We are indebted for these particulars to Mr. Alan Williams, M.I.E.E., of 28, Victoria-street, who represents the makers' interests in London.



STATOR GAS WASHING PLANT



MACHINE FOR HARDENING GEAR WHEELS

The Stator Gas Washer.

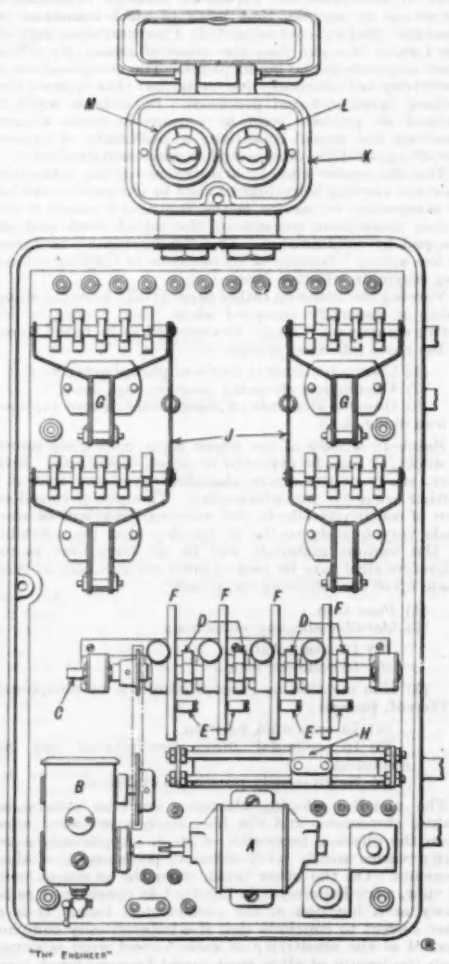
In our description of the Smithy Wood coking plant of the Thorncliffe Company, near Sheffield, which appeared in our issue of May 30th, 1930, we made reference to the gas washing plant for the purpose of the recovery of naphthalene from the gas. This plant, which was made by Newton, Chambers and Co., Ltd., of Sheffield, has now been in service for about three years and has given entire satisfaction. It is illustrated by the accompanying engraving. The washer deals with eight million cubic feet of gas per day of twenty-four hours and is used for the extraction of naphthalene, but the same design can, of course, be used for a variety of other gas cleaning processes. Briefly, the washer is composed of a number of compartments, filled with ring packing over which the absorbing liquid is circulated, and through which the gas passes in a horizontal direction at low velocity. An arrangement of spreaders and baffles in the compartments prevents by-passing of the liquid and ensures that the packing is thoroughly "wetted." The whole arrangement results in a maximum absorption from the gas, together with a minimum back pressure. The re-circulation of the absorbent from the sub-reservoirs, which communicate with the main reservoirs, maintains a low liquid level in the sub-reservoirs, thus eliminating by-passing of the liquid and ensuring that every molecule takes part in the wetting of the packing. The washer which we illustrate is made of steel, but they are also constructed of cast iron.

Automatic Traffic Signals.

A road traffic signal system which is claimed to be immune from the phenomenon known as "phantom" has been developed by Chance Brothers and Co., Ltd., of Lighthouse Works, Smethwick, Birmingham. Experience has shown that systems employing a parabolic reflector for increasing the power of the light beam are liable to give phantom signals, owing to the rays of the sun or those of the headlights of motor vehicles striking the upper surface of the lens and being reflected by the parabolic mirror. Needless to say, the effect may prove highly dangerous, and various schemes have been devised with the object of overcoming the trouble. One method commonly employed is to fit long and almost circular visors round the lenses, but the makers of the apparatus under consideration explain that the scheme has the grave disadvantages of obscuring the signal at close quarters and of failing to eliminate the "phantom" effects when the sun is near the horizon. A 12in. optical system has therefore been developed, which makes use of a special asymmetric lens capable of removing the trouble without the help of visors. The top half of the lens is formed with prisms to give a powerful indication in the main direction, and the lower half is provided with a flattened prism to give sideways and downward beams for near indication in addition to the forward beam. The angle at which the beam is projected may be altered by adjusting the position of the light source in the vertical plane, and the individual signals can thus be arranged to suit the gradients of the approach roads.

Without the use of a reflector, it is said to be possible to obtain a beam of 2000 candle-power, as compared with about 200 candle-power obtained with parabolic reflector systems, using the same size of aperture and the same candle-power lamp. If it is found necessary to increase the near indication beams use is made of a special type of reflector, which is claimed to serve the purpose without introducing the phantom effect. Independent angular adjustment of the signal units in the horizontal plane makes it possible to project the light beams in the most appropriate direction with regard to the angles at which the intersecting roads converge.

The principle of operation of the signal controller will be understood from the accompanying drawing, where A



TRAFFIC SIGNAL CONTROLLER

is a one-fortieth horse-power universal motor, coupled by a flexible coupling to the high-speed shaft of a double-reduction gear-box B, which drives the slow-speed shaft C by means of sprockets and a chain. On this shaft there are four fingers D, which on every revolution of the shaft touch the adjustable contacts in succession on the drums F. In this way the coil circuits of the quick-acting contactors G are closed at the proper instants, and these contactors complete the circuits of the selected signal combination. The speed of the motor, which, of course, controls the total cycle time, may be varied by the adjustment of the resistance H. The time of the cycle may be varied between 30 and 180 seconds, and each of the signal light periods can be varied independently by means of the calibrated drums F between the limits imposed by the cycle time adjustments.

After a contactor coil circuit has been closed primarily by the contacts D and E, the contactor maintains its own coil circuit until the succeeding contactor closes, and this system of electrical interlocking, together with the mechanical interlocks J, definitely prevents the possibility of indicating signals of the same sign on intersecting roads. Owing to the fact that the contactors are designed for very rapid operation, slow breaking of the circuit, and consequent arcing are avoided. The contactor contacts are of the roller type, and ensure that wear takes place evenly, and in circular form. The control panel is housed in a cast iron or aluminium waterproof case, with a manual switch-box K, containing two rotary switches L and M. The former is marked (*a*) red, green; (*b*) red and amber, amber; (*c*) green, red; and (*d*) amber, red, and amber; whilst the latter is marked (*a*) automatic working; (*b*) amber globes illuminated; (*c*) manual control; and (*d*) "off." In the ornamental base of each column support there is a sealing chamber to facilitate the interconnection of the multi-core armoured cable with the internal lamp leads.

Hardening Large Gear Wheels.

The illustration which we reproduce above represents the latest and the largest machine supplied for hardening gears by the Shorter process. It was made by the Patent Gear and Metal Hardening Company, Ltd., of 69, Horseferry-road, Westminster, and has been installed in the Darlaston works of the Wellman Smith Owen Engineering Corporation, Ltd.

The Shorter process, which we described in our issue of December 17th, 1926, is, it will be remembered, one in which the gear—it must, of course, be of ferrous metal—is rapidly heated to the critical temperature by means of an oxy-acetylene flame which travels over the surface to be hardened, and is immediately followed by jets of water that rapidly quench the heated spot. The result is a hardened surface layer which gradually merges into the softer metal of the core. At the same time the original dimensions of the gear are maintained, as the heating is so local that distortion is not produced.

The machine which has been installed at Darlaston is the largest of its type, being capable of handling gear wheels up to 7ft. 4in. in diameter, with a tooth face of 24in., with a circular pitch of ⅜in. or more. Special facilities have been provided for dealing with a variety of articles, so that areas can be locally hardened at points where excessive abrasion is likely to occur on heavy machinery parts. The Wellman Corporation will not only harden gears manufactured in its own works, but will receive other clients' gears within the vicinity of the works. The whole of the work will be carried out under the special direction of the inventors.

The improvements which have been introduced in the new machine relate in particular to facilitating and simplifying the operation. The heavy and cumbersome operating head of the old machine has been dispensed with by the introduction of a light carriage, worked on parallel bar slides. This alteration is of much importance as it has taken a considerable load off the motor and has facilitated a quick return and makes the machine operating head more adaptable. A very great improvement has been effected in the design of the burners, which has eliminated some of the early troubles in maintaining a constant flame working against water agitation. The friction drive has also been improved, giving a more positive grip and sensitive response to reverse. The operating tank has been fitted with removable sides, so that auxiliary tanks can be added to enable larger and more complicated work to be dealt with.

There were fifty-six iron blast-furnaces in blast in this country at the end of July, thirteen less than at the beginning of the month, eight having been damped down and five blown out. The production of pig iron in July amounted to 292,600 tons, compared with 311,400 tons in June, and 317,000 tons in July, 1931. Production included 57,500 tons of hematite, 135,300 tons of basic, 81,600 tons of foundry, and 11,400 tons of forge pig iron. The output of steel ingots and castings in July amounted to 430,300 tons, compared with 459,300 tons in June, and 428,700 tons in July, 1931.

A Modern Conception of Steel Quality.*

By H. W. GRAHAM, General Metallurgist, Jones and Laughlin Steel Corporation, Pittsburg, Pa.

In spite of all the elaborate precautions in steel testing, and in spite of narrowing down of chemical composition limits, it has become apparent, even to the uninitiated, that steel quality is an elusive property which is not clearly manifest from results of conventional, physical and chemical tests. In spite of all accomplished metallurgical progress, there are still instances, fortunately very few in number—wherein steel refuses to function normally in either fabrication or service, for no clearly ascribable reason.

H. M. Howe clearly recognised the inadequacy of existing metallurgical knowledge, and in his classical work, "The Metallurgy of Steel," published in 1890, he devotes an entire chapter to the subject "Treachery of Steel." Professor Howe specifically mentioned two mysterious cases of failure—the "Lividia Case" and the "Maginnis Case." Both deal with inexplicable failure in service of boiler plates which passed a rigid inspection, showed good physical properties, as judged by tensile and bend tests, with no indication of abnormalities in chemical composition. Although in the Maginnis case segregation of chemical elements was advanced as a plausible cause of failure, Howe admitted that this did not satisfactorily explain numerous instances where excellent service records were obtained from steel with a very high order of segregation of the same elements. The general metallurgical world knows very little more of the true explanation of such cases than did Howe in 1890. It is toward an understanding of these mysterious cases that the present paper is directed.

In the course of the investigation of failure, or unsatisfactory performance of steel, the task of the metallurgist is to point out the tangible causes of such unsatisfactory performance so that safeguards can be set up against the repetition of failures. Even a cursory examination of such investigations made by various workers clearly shows that in a preponderant number of cases the investigator has failed in his task. True, his report may on the surface sound convincing. He may have actually found "dirty" steel, large grain size, banded structure, chemical segregation, or insufficient ductility; yet, in all fairness to the painstaking efforts he may have put forth, the investigator must truthfully admit that similar conditions of structure, composition, or mechanical properties are commonly found in material which has given excellent service.

The Immediate Causes of Breakage.

Among the three causes of failure of steel in service, breakage is by far the most serious. At the worst, corrosion and mechanical wear are relatively slow processes and give sufficient warning of failure to permit proper plans to be made for replacement. But when a piece of steel breaks—dies a "violent death," as it were—the very least that can occur is an annoying delay to the activity involved and in many cases human life is endangered. If only one piece of steel in a hundred thousand breaks, that one failure rightly assumes a seriousness out of all proportion to the mathematical percentage involved.

Steel as produced in its hot-rolled form ordinarily possesses a high degree of resistance to shock; and hence, as long as this condition is retained, non-ductile failures by breakage are almost impossible. The fact that breakages can and do occur in steel parts is due to conditions that cause embrittlement and loss of the original shock-resisting power. Such embrittlement and the breakage that may result are of great importance in fabrication as well as in service life.

Embrittlement is ordinarily associated with an increase in hardness, the change of these two properties proceeding concurrently but not in an unvarying ratio. Under the working conditions of a given fabricating operation with a given grade of steel, embrittlement may not proceed sufficiently to cause any appreciable number of failures; but, on the other hand, hardness may increase to such an extent as to be a serious detriment to the ease of fabrication, with a consequent increase in cost.

It is known by experience that both embrittlement and hardening occur in greater or lesser degree under the conditions of:—

(1) Thermal treatment.
(2) Mechanical cold working.
(3) Natural ageing.

The Sensitivity of Steel.

In studying the behaviour of steel under conditions of heat treatment, cold working, or natural ageing, *it is essential to perceive that each individual piece of steel has its own characteristic response to these conditions.* It is not that steel as a whole responds to these conditions, but that *each particular piece reacts to the extent of its own capacity, which may be quite different from the capacity of the neighbouring piece.* When the significance of this variation in rate of reaction is grasped, a considerable light is shed upon those apparently mysterious cases of behaviour not explained by the hitherto conventional viewpoint.

The characteristic reaction rate of a piece of steel toward brittleness or hardness may be called sensitivity; or, in other words, *the sensitivity of a piece of steel is its characteristic degree of reaction to conditions of thermal treatment, cold work, natural ageing, or similar situations.*

Reduced to its simplest terms, metallurgical engineering resides in the production of steel at predetermined levels of certain physical properties. It is a fundamental quality of steel to exhibit certain physical properties and it is a practical fact that the level of these properties can be raised or lowered usually by simple methods of control. This system constitutes the basis of present-day ferrous metallurgy; but scrutiny of the results of this system shows that the level of properties desired cannot be produced with exactitude even in the unfinished steel, nor is there any permanence of these properties through subsequent operations on the steel. The variation experienced in steel as manufactured is considered the practical effect of a necessary working leeway.

The appearance of a wide range of behaviour in steel under fabricating operations impels the conclusion that there exists either undue looseness of method of control or, what is a more effective explanation, the existence of a group of agents which are not controlled by present methods.

The variation of steel in its response to external conditions is evident in heat treating, in mechanical working, and in ageing; and variation under these conditions will occur even in many steels of the same analysis. If sample bars are selected from two heats of the same carbon content of intermediate carbon steel and similarly quenched, one bar may be noticeably more embrittled than the other. When specimens from the same sample bars, from the same two heats are cold worked, one may again be more embrittled than the other. When the cold-worked specimens are subjected to natural or accelerated ageing, one will be more embrittled than the other by the ageing process. And, to generalise broadly, the specimen that reacted more sharply to quenching will also show the greatest response to cold working and to ageing. If a given steel reacts sharply to one treatment it may be expected to respond vigorously to other treatments. While these statements relate particularly to embrittlement, the situation with respect to hardening is apparently largely a similar one, although the correlation is not so clearly established at this writing.

This property of displaying a characteristic rate of reaction to varying conditions suggests a common origin or cause for the group of behaviour phenomena under discussion.

If the two steel samples above referred to are quenched, cold drawn, aged, and then reheated and again quenched, it will be found that one of the pair again responds more sharply, and it will be the same one that showed the greatest reaction in the first case. In fact, so far as is known to those who have prepared this paper, there is no thermal, mechanical, or electrical treatment below the melting point of steel which will permanently and fundamentally alter the characteristic response of a piece of steel to external conditions. (The wording here avoids including chemical or physico-chemical processes, such as carburising, pickling, or similar operations.) The specific value of any given physical property may be raised or lowered by appropriate treatments, but in a group of steel specimens each will maintain its own substantially unvarying level in a classification as to sharpness or sluggishness of response.

The above may be re-stated, as a very important conclusion, by saying that the characteristic sensitivity of a piece of steel does not appear to undergo fundamental alteration so long as that piece of steel maintains its identity—that is, is not re-melted. This conclusion suggests the further thought that the cause of sensitivity effects must originate in the liquid phase. The complications of sensitivity are inherently due to the fact that modern steel making involves liquid processes. If methods could be devised to produce steel at reasonable costs without reaching the liquid condition, a multitude of present metallurgical difficulties would become non-existent.

This discussion leads to a statement of the conception that the varying behaviour of steel to external conditions of fabrication or service is the result of a more or less active component present in the liquid steel and entrapped by solidification. This "component" is "more or less active" because of its presence in varying amount and varyingly effective form.

Viewing the situation rather superficially from the standpoint of generally accepted ideas, this "more or less active component" might be expected to be found in one of the three following groups:—

(1) Common elements (carbon, phosphorus, &c.).
(2) Uncommon elements (arsenic, tin, &c.).
(3) Gaseous elements or compounds thereof (oxygen, iron oxide, &c.).

Members of each of the above three groups are known to affect, or may be expected to affect, sensitivity. However, study of the above classification shows that it is neither scientific nor informative. Thoughtful consideration of sensitivity effects (the varying behaviour of steel) leads very quickly to the probability that the solubility of the various materials will be an important factor. Therefore steel may be viewed more scientifically as being made up of the following components:—

(1) Pure iron.
(2) Metallic alloying elements:
  (*a*) In true solution.
  (*b*) In colloidal form.
(3) Non-metallic or gaseous elements or compounds thereof, present:
  (*a*) In true solid solution.
  (*b*) In colloidal form, precipitated but not coalesced.
  (*c*) Extraneously present as inclusions.

The metallic alloying elements, such as manganese, nickel, chromium, and the like, have a profound effect upon the physical properties of steel. Apparently sensitivity varies widely with different percentages of these elements. On the other hand, from the practical point of view, very little error is involved in considering sensitivity as a function of the carbon steel base. It is at least correct to conclude that if a substantially complete control of the sensitivity of carbon steel were achieved, then the nature of alloy steel would be very much more simple and definite than is now the case.

In carbon steel the effect of non-metallic elements and gaseous compounds has been recognised, but not generally as originating in an adequate conception. It is customary to analyse for carbon, phosphorus, and sulphur; and the steel maker usually thinks he has performed his duty in controlling these elements.

The ease of visual detection of non-metallic inclusions under the microscope has led the metallurgist to overemphasise the importance of clean steel, as shown by the absence of visible non-metallics. Thus if the content of common elements is as required and a minimum of inclusions are visible under the microscope, both steel maker and metallurgist have viewed their product with at least a fair degree of complacency. Habits of working and habits of thinking have maintained this viewpoint and have made it difficult to recognise the influence of chemical elements that are not commonly analysed or of physical forms not easily observable under the microscope.

Even a practical metallurgical understanding of the behaviour of steel cannot be attained without considering all the conceivable factors. As illustrating the multiplicity of elements that may affect the behaviour of steel under conditions of thermal treatment, cold working, and ageing, the following list is given, and it is certainly only a partial list of the possible activating elements:—

Carbon—carbon monoxide.
Phosphorus—iron phosphide.
Sulphur—iron sulphide.
Silicon—silica.
Oxygen—iron oxide, manganese oxide.
Nitrogen—iron nitride, aluminium nitride.
Hydrogen—iron hydride.

The simple form in which the elements and compounds are above listed may be misleading. In a given case, observed vagaries in certain lots of steel may not be due to phosphorus or iron phosphide, but to the presence of a complex oxy-phosphide. The condition of variability may well reside in variation of chemical or physical form of complex combinations, rather than in the presence or absence of certain elements.

While phosphorus is mentioned here and at other points in connection with sensitivity, it is not suggested that it is considered the most important possible cause of sensitivity. One would rather suspect nitrogen as being the most influential element with oxygen as a fairly close second.

Sensitivity and Manufacturing Conditions.

In any several melts of steel manufactured by the same process and of the same chemical specification the variation in amount and in effectiveness of form of the activating elements will result from two conditions:—

(*a*) Variation in raw material.
(*b*) Variation in conditions of process.

Without attempting to consider the wide diversity of steel scrap, and its possible influence on steel quality, the part played by pig iron is undoubtedly a dominant one. Gradually more and more evidence comes to light that there are obscure phases of iron quality clinging tenaciously to the metal through the steel-making operations and existing to a greater or lesser degree in the finished steel.

The old-fashioned insistence upon cold-blast iron for making certain kinds of steel had some foundation in positive scientific fact. Certainly the hearth conditions in a cold-blast furnace are very different as affecting solubility of non-metallic or gaseous elements, partly by reason of the introduction of greater or lesser amounts of oxygen and nitrogen, with a consequent mass action effect, but also from those conditions present in a hot-blast furnace. In the small cold-blast furnace the lesser wind volume involves the introduction of less oxygen and nitrogen with a consequently decreased mass action effect, and also involves a concentration of the zone of high temperature. The absence of pre-heat in the blast contributes to a generally lower temperature level in the furnace. All these conditions are probably unfavourable to the solution of gaseous or non-metallic elements.

Further, the old idea, often scorned by supposedly well-informed metallurgists, that sand-cast pig iron was of a quality different from chill-cast iron, may be presumed to have a basis of fact in a different rate of freezing. Be that at it may, there does appear to be a discernible quality difference in sensitivity between steel made from molten pig iron and cast (cold) pig iron. This may be explained by assuming that in solidification the iron passes through an ejective phase which drives out some gas content or changes the form of occurrence of certain gaseous or non-metallic elements.

It is generally admitted that there remains much to be learned about pig iron quality. Efforts to institute investigational work have been hampered by lack of scientific understanding of the problem, and by the fact that the physical nature of pig iron does not lend itself to the type of tests that are so informative in dealing with steel.

That the steel-making process has its own effect, separate from the influence of raw materials, is shown by the apparent fact that the same iron will produce steel of different sensitivity by one or the other of the various steel-making processes. It would seem that the steel-making process either superimposes its own effect on top of pig iron characteristics, or that the steel-making process either retards or favours the loss of certain characteristics which the iron inherits from its manufacture in the blast-furnace.

It has been the commonly accepted viewpoint to believe that the sensitive response of Bessemer steel to cold working and similar effects is purely the result of its phosphorus content. In the light of present-day knowledge of sensitivity, this belief seems inaccurate. True, a Bessemer blow of 0·100 per cent. phosphorus is sensitive to mechanical cold work; so also is the basic open-hearth heat of 0·045 per cent. phosphorus which has gotten out of control, say, by phosphorus reversion after a heavy silicon addition; but, on the other hand, an open-hearth heat of 0·100 per cent. phosphorus made by the simple addition of ferro-phosphorus is relatively insensitive to mechanical ageing and other sensitivity effects. Thus it would appear that whatever influence phosphorus may have upon the characteristic sensitivity of Bessemer steel is not due to the mere presence of phosphorus, but to the fact that the phosphorus occurs in a critically active chemical or physical form.

A similar situation exists with respect to residual and added sulphur. There is reason to believe that neither phosphorus nor sulphur can be added, even as far back as the blast-furnace iron ladle, and a result obtained which is the same as the residual effect of these elements in the pig iron as tapped from the blast-furnace hearth.

Further, with respect to "added" elements, it may be well to point out that distinct although complex differences may be introduced into steel quality by variation in form, and particularly in the method of manufacture, of ferro-silicon, ferro-manganese, and other ferro-alloys. Differences in the sensitivity of steel to various treatments may be expected if the steel maker uses blast-

* American Iron and Steel Institute, New York, May 19th, 1932.

furnace Spiegel and ferro-silicon pig in one case and electric furnace silico-manganese in another.

With whatever raw materials and by whatever process steel is made, it is of great assistance toward simplification of thought and practice that within the limits of one melt of steel sensitivity seems substantially unvarying. The top of an ingot is more sensitive than the bottom and the last ingot more sensitive than the first, as might be expected in agreement with segregation. Aside from this relatively minor variation it seems that each heat may be considered a unit as to its expected reaction to thermal treatment, mechanical work, or ageing.

As to why carbon, phosphorus, or any other element should constitute a cause of varying sensitivity, is within the realm of the physicist rather than that of the metallurgist; but common knowledge of the behaviour of carbon and other less explored elements makes it plausible to attribute the variation in differences in amount, form, and solubility. When the steel solidifies the amount, and to some extent the form of each material, is fixed. As the temperature drops below the solidification point, however, the solubility of each material changes and a certain degree of instability ensues, resulting in various phenomena. The first of these phenomena is the group of structural carbon changes that take place at the various transformation points. There are a number of other phenomena, however, varying through a bewildering complexity, as influenced by variation in rate of thermal change, degree of mechanical work, and time element.

Thus the solubility of carbon, or iron oxide, or iron nitride will change as the steel cools from solidification to atmospheric temperature. Change in form or precipitation from solution may occur in varying degrees as favoured or limited by rapid or slow rate of temperature change. The exact behaviour in any case may be further affected by mechanical or natural ageing. Where precipitation occurs the particle size of the precipitated material may be expected to vary widely with a further extension of complexity and variation in result. It is not necessary to assume that sensitivity variations are due to precipitation of material that was in complete solution at the solidification temperature of the steel. To the common conception of elements or compounds existing in complete solution and as inclusions under the microscope we must logically admit the existence of the same materials in the complete range of particle size from the atomic or molecular required for true solution increasing up to that size visible under the microscope. This intermediate colloidal or emulsified form of inclusions may be very largely responsible for sensitivity effects.

If this is true—and it seems to agree with observed facts—particle size must be a very important factor. Physical considerations suggest more pronounced interference from the wide dispersion of material in very small particle size than from material present in a lesser number of very large particles. The converse of this reasoning is that particles in larger size are of less importance. Such conclusions minimise the influence of inclusions. In fact, the more one studies colloidal phenomena and sensitivity effects, the less one is apt to be concerned with conventional ideas about "dirty steel."

To a traveller in an airplane it is a beautiful sight to see a river divide on reaching a large island, flow quietly on both sides of it and join again on the downstream side. Even a group of islands, many of them in fact, seem to present comparatively little in the way of an obstacle to a river. But if one were to drive a 1in. round into the river bed and allow the upper end to project to the surface of the water, and then place one such 1in. round at the four corners of every square foot of surface of the river for a mile of its length, what an obstacle that network would present to the flow of the water! What a turbulent display of energy there would be! The entire area of the 1in. rounds would not add up to the size of one small island, nor could any or all of the rods be seen from the airplane of our tourist. This analogy crudely presents the view of the relative importance of inclusions and colloidal particles that this paper is intended to set forth.

But even some of those who argue that inclusions are extremely harmful are inclined to admit that there are other influences present, and admit that the effect of inclusions cannot be strictly isolated. Kinzel postulates a characteristic in steel which he calls "body." He finds "body" difficult to define and does not even suggest how or where it may occur. Apparently this investigator was working towards a conception of sensivitiy. In the light of the viewpoint which this paper endeavours to present, inclusions as visible under the microscope are the extreme of a long and continuous range of particle size. It is necessary, however, to recognise that inclusions may be few in number in clean steel, either because of a paucity of inclusion-forming material, or, in the presence of a considerable amount of inclusion-forming material, because of the relative absence of conditions favouring coalescence. The steel resulting under these two conditions would show a fundamental difference in sensitivity, even though classed as clean steel in both cases.

If one made a broad survey of the entire field of the reaction of steel to external thermal or mechanical force, one might first consider the field of high-temperature operations, such as welding, piercing, rolling, and forging. In this field relatively little scientific research has been made. Various investigations have involved rolling for instance, but the subject has almost always been studied through the physical properties of the cold steel product.

Undoubtedly visible inclusions are much more effective in the rupture of steel at high temperatures, but other conditions, nevertheless, enter into the situation to influence the behaviour of steel at high temperatures. Even in this relatively unexplored field, it may be expected that sensitivity and the variation thereof exist just as well as in cold steel, and resulting from the same group of causes.

In the range of temperature at the critical transformation points, sensitivity still contains many mysteries; but certain conclusions appear to be fairly definite. For example, it can be stated with a considerable degree of positiveness that the conventionally accepted ideas as relate to iron-carbide forms are inadequate to fully explain the variation experienced in watching heats of steel through commercial quenching operations. This does not mean that there is any wide area of error in present metallographic conceptions of carbon and iron carbide behaviour. Since ideas as to what takes place at the critical temperatures are necessarily based almost entirely upon examination of cold specimens, it may be that part of the variation experienced is due to factors entering at lower temperatures than those of heat-treatment, the effect of these factors being therefore superimposed upon the structural carbon effect.

Whether the origin be coincidental with or subsequent to the normal carbon changes, close scutiny of heat-treating results suggests the presence of agents supplementary to carbon. The argument here advanced is, however, unnecessary to the main proposition of this paper, since carbon alone would fully suffice to account for the existence of thermal sensitivity. What carbon does not account for is variation of thermal sensitivity as related to the carbon content reported by chemical analysis.

Although it may not necessarily follow that there is an absolute connection between thermal sensitivity in heat-treating and work sensitivity in mechanical cold-working, yet it has been noted that those heats of steel which show a great loss of impact strength on cold-working and which may therefore be classed as sensitive, will show a much more decided reaction to minor variations in quenching. In making this statement, the conclusion is, of course, confined to the same content of common hardening elements (carbon, manganese, and silicon).

Thus the heat that is found to be very sensitive to cold-work will show a wider spread of Brinell hardness with slight variations of quenching practice than will be experienced under similar variations of treatment with a heat of the same analysis of common elements which is relatively insensitive to cold-work. These observations support the thought that thermal sensitivity and work sensitivity arise from a common group of causes.

The most pointed effort that has been made to attack the problems of variability in heat treating—that is, variation in thermal sensitivity—is to be found in the work of Professor Crook, of Leland Stanford University. Professor Crook perceived the wide variation of reaction to quenching that is to be found in heats of approximately the same analysis of common elements; and he proposed a simple quenching test by which purchasers might reject heats of steel that did not harden sharply. That is to say, Professor Crook proposed the rejection of insensitive heats without any very broad explanation for their behaviour, whereas experience with large tonnages shows that, as might be expected, insensitive heats yield very uniform physical properties as contrasted to the wide and sometimes unacceptable variations experienced with the more sharply responding sensitive steel. Nevertheless, Professor Crook's work has undoubted merit and might well be used as the starting point for further investigation to tie in this test with other phases of thermal sensitivity.

Another heat-treating test was developed a decade ago by McQuaid and Ehn to distinguish steel that would quench uniformly hard after carburising, from that which would show irregular hardness under such conditions. Inasmuch as this would superficially appear to be a clear example of variable sensitivity, although in an extremely localised way, it would be expected that soft spots could be easily associated with other manifestations of sensitivity. However, considerable investigation by those who have prepared this paper has not as yet developed any correlation between sensitivity and abnormality. The lack of correlation with the McQuaid-Ehn test represents only one of the many phases of thermal sensitivity upon which further investigation is needed.

[The author then discusses in detail the reactions of steel to various external forces.]

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Position.

DEMAND for certain Midland and Staffordshire commodities has developed a moderate forward movement since the holidays, but, unfortunately, the iron and steel and other heavy engineering industries are no better off than they were. Some manufacturers are fortunate enough to have a fair reserve of orders in hand. The majority, however, have seldom had order books so sparsely filled. Indeed, some of the works which resumed production the week after the holiday are now experiencing difficulty in maintaining activity. There is a certain volume of optimism in local industrial circles, and there are expectations of an appreciable revival in demand in the early autumn. It is felt that if things go propitiously the autumn should bring a considerable reinforcement of demand. On all hands, it is made manifest that stocks have fallen very low, that there are great arrears in the world's requirements, and that if only demand could be implemented a tremendous impetus would be given to trade. Users of iron and steel, for the most part, hold that it will be soon enough to provide for development when it comes; consequently, they are buying only for known needs. There was a reasonably good attendance on 'Change in Birmingham this week for an August meeting, but the business transacted did not make a weighty whole. Selling prices were generally unchanged from those existing a week ago.

Steel.

The call for heavy steel is very restricted on account of the slackness in the constructional engineering and shipbuilding trades. Plants are working irregularly because of the lack of orders and poorness of specifications. Fortunately, some steelmasters think there are signs that the position will improve, and these makers are hoping that when the flow of trade is resumed in the autumn they will get a better share of any business in the market in view of the import duties. General engineering is, if anything, slightly better, but the increased momentum at the works is insufficient to make itself felt at the steel producing mills. Selling prices of finished steel are firmly held at the Association basis figures. Steel semis are in no better demand than they have been in recent weeks, and makers have to contend with severe competition from the Continent. How long the very low prices now quoted by these producers will last is a problem confronting merchants and consumers here. There is evidence this week that some Birmingham stockholders are inclined to put Continental steel into their warehouses after a fairly long period of restricted buying. Their reading of the situation suggests that the prices at which Belgium and France are prepared to accept orders cannot last much longer. If the endeavours to effect international collaboration should succeed, drastic revaluation may result. Staffordshire re-rollers, though they are in urgent need of orders, hold out for £6 7s. 6d. for re-rolled bars at upwards of £7 for all-British bars. Billets are quoted £4 17s. 6d. to £5 7s. 6d., and Staffordshire hoops at £9 10s. per ton.

Finished Iron.

There is not sufficient work to keep plants producing finished iron operating for more than three days a week. Orders are very scarce, there having been no improvement in the volume of trade since the resumption of activity after the holidays. The dull conditions are likely to continue until the end of this month, after which it is sincerely hoped there will be a more general buying and a decided progressive movement in the industry. At date the position gives cause for much concern, and ironmasters have considerable difficulty in arranging any sort of programme. Selling prices are unchanged on the week. Marked bars make £12 per ton at makers' works, Crown bars sell at from £9 to £10 per ton delivered. Wrought iron gas tube strip quotations are steady at £10 7s. 6d. to £10 10s., as are those of fencing bars at £7 15s. and nut and bolt bars at £8. Belgian No. 3 iron is still on offer at low rates, but users here have stocks sufficient for current needs.

Raw Iron.

Blast-furnacemen in the Midlands are anxiously seeking specifications, though they are, in most cases, inclined to the opinion that there is not now likely to be any real expansion in the volume of demand until September. Derbyshire and Northamptonshire smelters are disposing of small parcels of iron to ironfounders in this area, but the ironfounding industry as a whole is taking much less material than is customary at this period of the year. Associated pipe foundries continue to absorb a good proportion of the iron produced in Derbyshire furnaces, while Northamptonshire makers are selling some foundry material in Northern markets. Output, however, remains in excess of current needs, and stocks at the furnaces are growing. Selling prices are unaltered on the basis of £3 6s. for Derbyshire and North Staffordshire No. 3 foundry, and £3 2s. 6d. for Northamptonshire. Forge grades are 5s. per ton less in each case. Blast-furnacemen have no difficulty in securing adequate supplies of coke. Indeed, they are, in many instances, to-day, getting coke on terms which compare favourably with those which prevailed in pre-war times. The output of the coke ovens is reported to be larger than can be absorbed in the present state of trade.

Galvanised Sheets.

There has been no alteration in the trade position in the galvanised sheet industry during the week. Orders are scarce and relate chiefly to small tonnages for overseas users. Millowners in this area are endeavouring to keep up prices and 24 gauge corrugated sheets continue to be quoted £9 2s. 6d. to £9 5s. per ton. Competition for the business available is very keen and orders are undoubtedly accepted by some mills at lower prices than those generally quoted. As far as can be ascertained, however, £9 per ton is the minimum price acceptable to Midland producers.

Price Changes.

Of considerable importance to Birmingham are the recent changes in basis prices of rolled and drawn metals. Strong copper sheets have been advanced £3 per ton to £62. Cold-rolled copper strip has risen by a similar amount to £65. The rise of a farthing per pound on solid drawn brass tubes makes the price 9d. Solid drawn copper tubes have advanced a halfpenny, becoming 10d., and brazed brass tubes, by the addition of a farthing, become 11d. These are country, not town prices.

Lower Imports.

Iron and steelmasters in common with manufacturers in the Midlands and Staffordshire were pleased to learn from the Board of Trade returns for July that there was a marked decline in imports. They noted, with satisfaction, that the total imports for the month were £5,596,000 lower in value than in the previous month, and £18,236,912 lower than in July of last year. More than half the decrease in comparison with last year was in articles wholly or mainly manufactured. Iron and steel and their manufactures, and non-ferrous metals and manufactures together, showed a decline of £2,017,864, the aggregate decline in these two classes for the seven months of the year to date being £8,827,473. The total quantity of iron and steel imported during the month was 118,740 tons, valued at £548,982, compared with 231,017 tons and £1,557,035 in the corresponding month of last year. For the year to date the quantity imported was 1,086,233 tons, valued at £6,053,758, compared with 1,507,794 tons and £10,650,190 in the preceding year.

Coventry Aero-engine Trade.

The aircraft aero-engine industry in Coventry continues to make steady progress. Aero-engines are being made by the Armstrong-Siddeley Company, both for fighting machines and air liners. In the former category an important order has just been placed with the firm by the Belgian Government for a number of 200 H.P. engines for the Belgian Air Force. This, in addition to the big contract placed by Imperial Airways, Ltd., some time ago, for the construction of a fleet of giant four-

engined monoplanes for use on the trans-African route between Cairo and Cape Town, will keep the industry busy for some time.

Obituary.

The death occurred at Wolverhampton on Sunday last of Mr. A. E. Jenks, of Ash Grove, Compton, Wolverhampton, at the age of seventy. Mr. Jenks was one of the founders of Jenks and Cattell, Ltd., manufacturers of pressed work and washers, Heath Town and Wednesbury. He was a director also of Deritend Stamping, Ltd., Birmingham, and Collaro, Ltd., London. For many years he was a member of the Birmingham Iron and Steel Exchange, and was a familiar figure at the weekly gatherings. He was held in high esteem in Midland industrial circles.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Engineers and Export Credits.

ABOUT a month ago questions were put by Lancashire Members of Parliament in the House of Commons regarding the attitude of the Export Credits Guarantee Department towards Russian contracts for engineering products, which had been, or were about to be, placed with Lancashire firms, and the answers given by the Secretary to the Overseas Trade Department, hinted at a rapidly approaching crisis in connection with this matter. Engineering concerns in Lancashire, as well as in the West Ridling of Yorkshire are understood to have the opportunity of securing further business with Russia in textile machinery, machine tools, and other engineering products to follow up contracts that are being completed, but the difficulty of obtaining export credits from the Government Department is standing in the way. The matter has now reached the critical stage, where dismissals of workmen by local engineering concerns have been made during the past week or so, the reason given being that Russian contracts in hand are approaching completion, and that, because of the difficulties in the way of securing credits, engineers are finding it impossible to finance the further contracts that are available. At a meeting last Sunday, attended by many of the Manchester engineers who have recently lost their employment, it was stated by officials of the Amalgamated Engineering Union that in the second half of last year firms in the Manchester district had secured Russian orders for electrical equipment, machine tools, pumps, power hammers, rubber machinery, and coke oven plant to the value of something like £1,000,000.

Continued Improvement in Textile Machinery Exports.

The Board of Trade returns continue to reflect a gradual though steady improvement in the exports of British textile machinery, the July shipments not only representing an improvement, both in quantity and value compared with a year ago, but also being above the average of the preceding six months of the present year. In certain directions last month's exports compare unfavourably with those in the corresponding period of 1931, but an expansion in the takings of British India, China, Japan, Australia, and South America has more than made good this deficiency. The July shipments of 5950 tons, valued at £526,106, compared with 4586 tons and £495,481 a year ago, and included 4235 tons of spinning and twisting machinery, valued at £367,691, and 1269 tons of weaving machinery, valued at £105,066. In the seven months, January–July, the aggregate exports have amounted to 39,363 tons and £3,425,148, against 30,316 tons and £3,082,691 in the corresponding period of 1931. British India easily retains the first place as a market for British textile plant, the shipments thence last month being valued at £189,580; Japan occupies second place with £74,897; followed by China, £46,125; South America, £34,410; the Netherlands, £17,244; Germany, £12,007; France, £11,965; Australia, £11,680; the United States, £9934; and Russia, £2488; shipments to "other countries in Europe" in July showed the rather substantial decline to £70,716 from £112,193 a year ago.

Oil Engine Omnibuses and the Fume Problem.

The Manchester Corporation Transport Department is shortly to install a centrifugal machine for the treatment of oil fuel and the extraction of impurities, and it is hoped that when this is in operation a further substantial amelioration of the fume nuisance from the oil engine omnibuses in service on the Manchester system, regarding which there has been much complaint, will be effected. Mr. R. Stuart Pilcher, the city transport manager, states that it has been proved as a result of an independent series of analyses that the exhaust fumes from the heavy oil-engined omnibuses under all sorts of service conditions are much less noxious than from the petrol-driven vehicle, especially from the point of view of carbon monoxide discharge. It is claimed that already within recent weeks much has been done towards reducing the smell as well as the density of the fumes discharged from the oil engine omnibus, and it is hoped that much more will be achieved in this respect before long.

Non-ferrous Metals.

Interest in all sections of the non-ferrous metals market has continued at the improved level of the two previous weeks, and in all cases, although on a less pronounced scale, the upward movement of prices has gone on. On occasion there has been slight reaction due to spells of profit-taking, but the setbacks were not so serious as might have been expected; in any event a full recovery was made. The turnover in copper during the week has been substantial, and values of standard brands are higher on balance to the extent of about 15s. per ton. Tin has also attracted a fair amount of attention from buyers, although, as with copper, the bulk of the business has been speculative in character. Compared with the last report, tin values have moved up by rather more than £3 per ton, making the net advance during the past three weeks one of nearly £20 per ton. Buying interest from trade consumers has been somewhat more prominent in an active lead market, and a further gain of from 5s. to 10s. per ton has to be recorded. Spelter is dearer on balance by between 10s. and 12s. 6d. per ton, and here also a better buying movement than was experienced a week or two ago has been in evidence.

Iron and Steel.

Notwithstanding the possibility of serious labour troubles before long in the Lancashire cotton industry, the iron and steel markets have been disposed in some quarters to take a slightly better view of prospects in the early autumn. For the time being, however, trade is distinctly under the influence of the holidays, although in foundry iron the past week has witnessed a little more business on forward account, without, however, any expansion in the volume of deliveries into consumption compared with recent levels. Quotations keep up at 67s. per ton for Staffordshire and Derbyshire No. 3, 65s. 6d. for Northants, 62s. for Derbyshire forge, from 84s. 6d. to 85s. for Scottish No. 3, and about 81s. for West Coast hematite iron—all for delivery Manchester or equal distance. The bar iron trade is quiet, but steady on the basis of £10 5s. per ton for Lancashire best bars and £9 15s. for Crown quality material. Constructional engineers locally are handling a few inquiries, but they rarely involve much tonnage of steel, and the demand locally for all classes of steel at the moment, including the alloy products, is rather slow. Quotations are steady, however, at late rates.

BARROW-IN-FURNESS.

Hematite.

Business continues to be very quiet in the hematite pig iron market, but there is some chance of an improvement when August is over and when customers' works restart. Although there are few furnaces in blast, the output is hardly being cleared, and a certain amount is going into stock. The Barrow furnaces which are being overhauled are likely to go into blast shortly, but the date of restarting them will depend upon the steel orders held. The Backbarrow furnace, which is engaged on special quality iron, is at present undergoing alteration, new overhead gear being introduced, with a view to avoiding the carriage of raw material over the main road. This furnace at one time produced charcoal iron. The native iron ore trade is very quiet, and it is stated that there is on the surface over 100,000 tons awaiting orders. Foreign ore is in quiet demand. The steel market is quiet, but the news that Crewe will close down in a month or two raises hopes locally that in future Barrow will get a share of L.M.S. orders. The hoop and small section mills are again at work at Barrow.

Shipbuilding.

Vickers will launch from their Barrow yard on August 30th the British submarine "Porpoise," and on September 1st they will put into the water the "Queen of Bermuda," which has been built at Barrow for the New York–Bermuda service for Furness, Withy and Co., Ltd.

SHEFFIELD.

(From our own Correspondent.)

Larger Steel Production.

THE statistics of steel production in this area during June, which have just been published, prove to be comparatively favourable, showing an increase on both the previous month and on the position of a year ago. The month's output of steel ingots and castings amounted to 68,100 tons, as compared with 63,800 tons in May and 56,800 tons in June last year. The total included 21,200 tons of acid and 41,700 tons of basic steel. North Lincolnshire also recorded an advance, its production in June, consisting almost entirely of basic steel, being 42,000 tons, as against 34,200 tons in May and 36,200 tons in June, 1931. The same area also produced 42,600 tons of pig iron in June, the comparative figures being 40,500 tons in May and 34,300 tons in June last year. The improving tendency of the open-hearth trade is a cheerful and very welcome feature of the situation. The position at the rolling mills, however, shows no progress, but rather a decline compared with a month ago.

Hope of Railway Work.

It is officially announced by the L.M.S. Railway Company that its steel works at Crewe will be closed on September 30th, and it is understood that between 500 and 600 men will be affected. This decision, unfortunate as it is for Crewe, is expected to be of some benefit to the Sheffield trade in railway material, which has for a long time been sadly in need of more work. A substantial amount of trade in rails, fish-plates, axles, tires, springs, and several other commodities will, it is thought, be available for private firms, and it is hoped that a good proportion of this business will come to Sheffield. It has for some time been argued by members of the steel trade that the works in question, having no other market than the requirements of a single customer, cannot be carried on economically; and is unable to produce as cheaply as firms supplying the demands of numerous customers. The existing plants for making railway steel exceed the present or probable future consumption. Mr. P. B. Brown, managing director of Hadfields, Ltd., and an ex-Master Cutler, in an interview, said that he did not expect that Sheffield would benefit from the closing of the Crewe works for the next few months, but the city would hope to get some trade when the company found itself in a position to order new rolling stock.

Steel for Russia.

A good item of news this week is that Russian orders for several hundred tons of expensive high-speed and other alloy steels have been placed in Sheffield. The business is valuable, representing a large sum of money, and several firms are sharing in it. It is stated that other orders could have been obtained, but very long credit was required, and, Government guarantees not being available, the firms to which they were offered could not finance them. It is also reported that Germany is obtaining much more business for tool steel for Russia than is being placed with local firms.

Departmental News.

There is a well-sustained demand for stainless steel and kindred materials, and also for steel strip and best wire. The automobile trade continues to be a good customer for parts of cars which are subjected to the most severe wear, and for special steels. In the tool trades, taken as a whole, conditions are unsatisfactory, but there are some notable exceptions. A substantial amount of work has been obtained for several factories recently by the booking of a number of orders for overseas. The position in the home market shows no improvement, but rather the contrary, especially as regards tools used in shipyards, in constructional work, quarries, and factories. The situation has been adversely affected by the holding up of important constructional public works in various parts of the country for reasons of economy. In high-class precision tools Sheffield is obtaining an increasing share of such work as is available. There is only a moderate demand for building trade tools, while the file and farm tools trades are quiet. There is no news yet of the establishment, in Sheffield or elsewhere in this country, of factories by American firms for the production of tools and other goods which are now subjected to tariff. The economic slump in America, and the shortage of money there, are suggested as probable reasons why the numerous inquiries made in this country by American firms have so far failed to materialise.

To Exhibit at Copenhagen.

The recent increase of this country's export trade to Denmark adds interest to the British Industrial Exhibition, which is to be held at Copenhagen from September 24th to October 9th. Our exports to that country during the current year have nearly doubled, and there is therefore every encouragement to home manufacturers to make a display of their products. Sheffield firms which have taken space at the Exhibition include Brown, Bayley's Steel Works, Ltd., Thos. Firth and John Brown, Ltd., Harrison Fisher and Co., Ltd., George Ibberson and Co., Mellowes and Co., Ltd., James Neill and Co. (Sheffield), Ltd., and Sheffield Steel Products, Ltd.; while among the district firms to be represented are Ferodo, Ltd., of Chapel-en-le-Frith, and John Ormerod and Sons, Ltd., of Castleton.

Cutlery and Plate.

The cutlery and plate branches have been, generally speaking, very quiet for a long time, and nothing favourable has yet developed in them. There is not, however, any falling off from the standard of recent months, which is a matter of comparative satisfaction, as the present period is always the dullest of the year. It is fully expected that the position will become brighter in September. The Government returns for July show an increase in exports, but at the same time an increase in imports. The exports for the month amounted to £71,287, which was considerably better than the £57,186 of July, 1931, but still much below the £104,884 of July, 1930. The total for the seven months of this year is £419,763, as against £346,771 in 1931 and £535,859 in 1930. Imports in June were £21,012, and it would appear that the removal of the dumping duty of 50 per cent. and the substitution of the present 20 per cent. duty is leading to a growth under this head, as the figures for April were only £9669. The total is still comparatively low, as the imports in July, 1931, amounted to £40,229, and in July, 1930, to £38,156.

NORTH OF ENGLAND.

(From our own Correspondent.)

Order for Two Blast-furnaces.

JUST at a time when work was getting slack at their Thornaby and Stockton works, Head, Wrightson and Co., Ltd., have secured an order for two blast-furnaces for the Stanton Iron and Steel Company, Ltd., Nottingham. These furnaces are in addition to five which have recently been completed for the same firm, and are stated to be for a subsidiary company, the Wellingborough Iron and Steel Company, Wellingborough, which is to modernise its blast-furnace plant. The order will provide regular employment for the company's ordinary staff and workmen. For some time the Stockton Forge and the Stockton Steel Foundry have done very little and the contracts in hand have been centred at the Teesdale Works, Thornaby. The blast-furnaces are built under special patents by Head, Wrightson and Co., Ltd., and the repeat orders point to the success which has been attained by them.

Cleveland Iron Trade.

With all the local consuming works closed for the annual holidays, sales and deliveries in this area have virtually ceased, and there is little external demand. Even Scotland is taking reduced quantities. The bulk of the iron made this week is going into stock, but the furnaces are not being forced and four at the Skinningrove Ironworks are damped down. Most of the works will restart on Monday next, but it does not appear that anything beyond the recent restricted operations will be possible. Values are unchanged, No. 1 Cleveland pig iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Notwithstanding the curtailment of output of East Coast hematite pig iron the market is weak, and

the nominal quotation of 61s. for mixed numbers is being cut by merchants, who are large holders, and in some cases by producers also.

Ironmaking Materials.

The foreign ore trade is almost at a standstill Consumers have big stocks and deliveries to take under running contracts. Best Rubio ore is quite nominal at 14s. 9d. c.i.f. Tees. Sellers of good medium blast-furnace coke are anxious to reduce stocks, and offer good medium qualities at 14s. 6d. delivered at works in this area.

Manufactured Iron and Steel.

With one exception, where operations have only been suspended for two days, all the steel works are closed down for the week. Departments engaged on the production of constructional steel have quite good order books, and report that work is still coming in, but in nearly all other sections new contracts are urgently needed. Prices are unchanged.

The Coal Trade.

There is no noticeable change in the Northern coal trade outlook. Output, on the whole, is steadily cleared, not because there is any better demand, but by reason of the fact that production has been so severely curtailed as just to meet the requirements of the market. Occasionally a colliery may be rather short, but not sufficiently so to justify the reopening of a pit or seam. It often happens, after a decision to increase output has been made, that orders fall off once more, and another stoppage is rendered necessary. In the Northumberland steam coal section the position is much the same. Collieries are moderately booked and stemmed, but anticipate being able to clear all output under present working arrangements. Best screened steams remain at 13s. 6d., and smalls being sparingly offered and under good demand are quoted firmly at 8s. 6d. Tyne prime steams are moving quietly at 12s. 6d., with small firm under limited supplies at 9s., while Wear prime large have a fairly good forward inquiry, and are steadily held for prompt at 15s. to 15s. 1½d., small being steady at 11s. to 11s. 1½d. Durham gas and coking coal of any grade is plentifully offered, and production at the pits is severely limited. Demand is barely sufficient to absorb the restricted output, and prices remain easy. Best gas qualities are 14s. 6d., secondary 13s. to 13s. 6d., and special Wear kinds 15s. Durham coking unscreened is quoted at 12s. 6d. to 13s. 3d., while unscreened bunkers are in good prompt demand, but neglected forward, with values just steady at 13s. 6d. to 13s. 9d. for superior and at 13s. to 13s. 3d. for good ordinary brands. The demand for foundry cokes is limited, and business remains stagnant. Patent oven ordinary qualities offer at 14s., and superior makes 15s. to 16s. Gas coke is being cleared off in good volume, stocks showing little or no increase, which is quite a satisfactory feature at this period of the year. Prices, prompt or forward, remain firm at 17s. to 17s. 6d.

SCOTLAND.

(From our own Correspondent.)

New Industries.

THERE is a possibility that a factory for the manufacture of household goods and cooking utensils may shortly be opened in the Glasgow area. The Scottish National Development Council has been busy interviewing buyers of metal work, ornaments, &c., and cooking utensils. Fruit-canning factories are also under consideration in Lanarkshire, and possibly Perthshire. The building, equipment, and supplying of materials would probably be beneficial to various local industries.

Steel Works Reopen.

Work has been resumed at the Hallside Works of the Steel Company of Scotland, where operations have been suspended for about four months.

Shipbuilding Order.

It is announced that George Brown and Co., Greenock, has received an order to build a coaster of about 400 tons for British owners. This contract is noteworthy, constituting as it does the second order received in Greenock this year. The other order was that for the steamer for the China Navigation Company, Ltd., London, which is being built at Scotts' yard.

Steel and Iron.

There is still no definite sign of a revival in the Scottish steel and iron trades. Makers are, however, apparently more confident with regard to the export trade. Sheet makers are comparatively well employed, and there has been a little more business in tubes, but the demand for plates and sections continues to feel the dearth of shipyard orders, which, although a shade better than before the holidays, are yet rather trifling compared with normal times.

Iron.

In connection with bar iron and re-rolled steel bars, there is nothing new to report. They continue rather dull and prices are unchanged with re-rolled steel bars quoted £6 10s. home (fixed) and £6 7s. 6d. per ton export.

Pig Iron.

The production in Scotland consists of the output from one furnace. Stocks are ample, and demands easily supplied. Last week a cargo of 1300 tons of pig iron arrived at Glasgow from India. Shipments from Glasgow amounted to 337 tons, 331 tons of which went abroad.

Scrap.

Prices of scrap show no change, cast iron machinery being quoted at 45s. and heavy steel at 35s. per ton.

Coal.

The outstanding feature of the coal market is the growing strength of smalls. Treble and double nuts, especially the former, have been firm for some time back, and now the smaller sizes are receiving increased attention. Good inquiries have been received from Denmark of late. On the other hand, there is a dearth of orders for large coal for shipment at a time when supplies are augmented by supplies of fuel usually absorbed by the home market. The collieries, as a rule, however, are holding out for full recent prices, and are apparently not disposed to make concessions for any class of business. Aggregate shipments amounted to 245,410 tons, against 209,954 tons in the preceding week and 187,773 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THESE are very dull days in the coal trade, excepting, of course, anthracite, which has recovered from the temporary easing off in shipment pressure which was at one time last week apparent. Since then tonnage has come along more freely and at Swansea on Monday there were five steamers waiting to berth. In contrast to this, the position at the steam coal loading ports was very different, though it must be said that on Monday there were only nineteen tips idle at Newport, Cardiff, Penarth, Barry and Port Talbot, whereas on the preceding Saturday the number of vacant berths was forty-one. As was only to be expected, shipments of coal and coke from the six leading ports last week registered an improvement upon the returns for the preceding week, when the conditions were detrimentally affected by the holidays. The total came to 371,215 tons, as compared with 244,765 tons, though, for the corresponding week of last year, the quantity was 466,852 tons. The trouble at the present time is the shortage in the inquiry for coals for early shipment. The demand from abroad is very meagre, and it is not surprising to find that outward rates of freight have shown greater weakness than ever. There are, of course, a few single cargo orders about, including one of 6000 to 7000 tons for account of the Palestine Railway for delivery at Haifa, but much more business is required to create any feeling of activity. So far as contract operations are concerned these are distinctly quiet, but though the order may not come to South Wales it is cheering to find that, according to an official statement, the Latvian Government has not accepted the proposal of the Polish Government to supply them with 200,000 tons of coal. On the contrary, the Latvian Government intends in the near future to invite British coal exporters to submit tenders for 50,000 tons of Scottish, Durham, Northumberland, Yorkshire and South Wales coals. It is interesting to note that Latvia took during the first six months of this year 66,000 tons of British coal, as compared with less than 2000 tons in the first six months of 1931. Business in coals from this area for the Irish Free State continues to be negligible, and it is known that one leading Irish railway company is in the market for supplies of German coal, whereas this particular railway undertaking is not taking Monmouthshire coals for which the company had contracted.

Coal Restrictions.

Recently it was announced that the Belgian Government intended to reduce its coal import quota by 50 per cent. as from the beginning of this month, but this week it transpired that the Government has abandoned this intention, with the result that the quota remains the same as for July, viz., 55 per cent. of the average imports in the first half of 1929, which means a total of 93,250 tons of British coal for the current month. It is stated that the reason for the postponement of the change is that negotiations with the German Government are still in progress. News from Spain is not so satisfactory, as reports are to hand that that country intends to place further restrictions on coal imports at the end of this month by stipulating that additional undertakings in Spain shall take only a certain percentage of their coal requirements from outside Spain, which virtually means that imports shall be less and that Spaniards must consume increased quantities of native coals. No details of these new restrictions are, so far, to hand. The report has also been revived that France proposes, as from the beginning of October, to insist that coals exported to that country shall only be carried in French bottoms. This report is discredited, inasmuch as French shipowners do not own anything like sufficient quantities of the tonnage suitable for the trade, and any such condition would dislocate entirely the arrangements of French consumers who also would have to pay substantially higher prices than at present for their coal supplies.

Wages and Working Conditions.

Negotiations were opened this week concerning important wage questions as affecting men employed in South Wales. In the first place men's representatives met the ship-repairing and engineering employers concerning a revision in the wage rates and working conditions of the employees, but it will be some time before an agreement will be hammered out. It has often been pointed out that the dry dock owners and ship-repairers are at a disadvantage in competing with other areas in this country and on the Continent owing to the onerous working conditions in South Wales. There was also to be a meeting in London on Wednesday to consider the Shipping Federation's proposal to reduce the national tariff applying to coal trimmers by 10 per cent. About 2500 men are affected in South Wales. The proposal of the employers will, without doubt, be strongly opposed on the ground that owing to the diminished activity in coal exportation the men's earnings are already severely curtailed.

Works Restart.

An improvement in the industrial conditions at Llanelly is reported as the result of three furnaces being placed in commission at the Llanelly Steel Works on Monday. These had been closed down for a fortnight The bar mill was also restarted at Messrs. Richard Thomas and Co.'s South Wales Steel Works, where three furnaces were relighted last week. A resumption of work also took place at the Western Tin-plate Works and the Old Lodge Tin-plate Works, which had been idle since the end of July. On the other hand, several thousands of pounds of damage was sustained by the Llanelly Tin-stamping Works as the result of a fire early on Monday morning. The works power station, the machine shop, fitting shop, smithing and pickling departments were destroyed, and it may be several weeks before very valuable machinery can be replaced. The more advanced processes of the industry are able to continue operations as the result of considerable stocks in hand. The works are owned by the Welsh Tin-plate and Metal Stamping Company, Ltd.

Current Business.

Anthracite coals are firm all round, but steam coals are very quiet in comparison. Dry coals, which are in demand on account of the tightness of anthracite, are a good market, and command 1s. or more in the case of sized qualities above the minima, but large and small coals are freely offered, and stocks are very excessive. Patent fuel is well stemmed, but there is no improvement in the coke section. Pitwood is being brought along in restricted quantities, and prices rule very steady at 23s. to 24s.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

FUELS FOR HEAVY-OIL ENGINES.

THE British Standard Specification No. 209 for Fuels for Heavy-Oil Engines, published in 1924 by the British Standards Institution (then the British Engineering Standards Association), has recently been under review by the Committee responsible for its preparation, in accordance with the usual practice of the Institution when a specification has been in use for a number of years. After discussions lasting several months, certain revision was proposed by the Committee, and—again in accordance with the Institution's practice—was widely circulated throughout the country for comment. A number of interesting comments were received, the whole tenor of which seemed to show the very controversial nature of the subject, and the Committee came to the conclusion that these comments were due to the fact that there was at present insufficient data available on the subject of Diesel fuels. These comments and, more important still, the inability of the Committee to include in the specification certain factors governing the behaviour of an oil in the engine (such as spontaneous ignition temperature, delay angle, reduction of shock, &c.) with which at the present stage of knowledge the Committee felt it quite impossible to deal, caused it to decide that it would be wiser to postpone the revision of the specification for at least twelve months or until such time as it feels that an adequate specification for performance can be drawn up. The Committee realises the rapid development of the class of engine for which these fuel specifications are intended, more particularly the light high-speed Diesel type, and has in mind the work being done both in this country and in the United States. In the meantime, therefore, the Committee is co-operating with the Institution of Petroleum Technologists in the development of suitable tests which can be included in the specification when it is revised, and is also keeping in close touch, through the American Standards Association, with the work being done in the United States.

In view of the above, the Committee would be grateful to users and manufacturers of Diesel engines if they would communicate any experience or comment likely to be useful in arriving at a comprehensive specification for Diesel fuel oils. An addendum slip calling attention to this decision is being included in British Standard Specification No. 209—1924, and copies of the slip will be forwarded free of charge on receipt of a stamped addressed envelope, by the Publications Department, British Standards Institution, 28, Victoria-street, London, S.W.1.

EDUCATIONAL INTELLIGENCE.

UNIVERSITY OF BRISTOL.—A prospectus of the Faculty of Engineering, which is provided and maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College, Bristol, has just reached us. Courses of study are available at the College for persons intending to engage in civil, mechanical, electrical, and automobile engineering, and particulars of these courses are given in the prospectus. The ordinances and regulations relating to degrees and diplomas in engineering subjects are also included. The prospectus can be obtained from the Registrar of the Merchant Venturers' Technical College, Bristol.

CONTRACTS.

SIR WILLIAM ARROL AND CO., Ltd., have been entrusted with a contract from the Southern Railway for the reconstruction of Streatham-road Bridge at Mitcham-lane, London. The work has to be completed in six months.

ASKANIA REGULATORS.—In the course of our description of the coke oven plant at Scunthorpe, in our issue of July 29th, we mentioned the Askania regulator as being used to control the gas pressure in the mains. We have been asked by Reavell and Co., Ltd., of Ipswich, to explain that this regulator is now manufactured by themselves for use in the British Empire, and is sold as the Reavell-Askania regulator.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 22/6
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	14/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 1 0	3 1 0
No. 1	3 1 6	3 1 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*) / 4 0 6 (*b*) / 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
Lancs.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 0 0	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0 to 7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0 to 8 12 6	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets, f.o.b. L'pool	9 2 6 to 9 7 6	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/0 to 15/6
Block Tin (cash)	143 7 6
„ (three months)	145 0 0
Copper (cash)	30 17 6
„ (three months)	31 0 0
Spanish Lead (cash)	11 5 0
„ „ (three months)	11 10 0
Spelter (cash)	13 16 3
„ (three months)	14 1 3
Manchester—	
Copper, Best Selected Ingots	34 10 0
„ Electrolytic	35 15 0
„ Strong Sheets	62 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9
„ Condenser, lb.	0 0 11¼
Lead, English	13 2 6
„ Foreign	11 15 0
Spelter	14 2 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/– per lb.	
Ferro Tungsten	1/9 per lb.	
Ferro Chrome, 4 p.c to 6 p.c. carbon	£25 0 0	8/–
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 15 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	11/–
„ „ „ 1 p.c. carbon	£47 0 0	14/–
„ „ „ 0·70 p.c. carbon	£48 0 0	16/–
„ „ „ carbon free	1/1 per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 6/– per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	8/– per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/–
„ „ Ell	14/–
„ „ Splint	13/9 to 14/9
„ „ Trebles	13/– to 13/6
„ „ Doubles	11/6
„ „ Singles	10/–
Ayrshire—	
(f.o.b. Ports)—Steam	11/6
„ „ Jewel	16/6
„ „ Trebles	13/– to 13/3
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 12/6
Screened Navigation	16/6
Trebles	14/6 to 15/6
Doubles	12/–
Singles	10/–
Lothians—	
(f.o.b. Leith)—Best Steam	11/– to 11/6
Secondary Steam	10/6
Trebles	13/– to 13/3
Doubles	11/6
Singles	9/9 to 10/–

(8) N.W. Coast— ENGLAND.

Steams	21/9
Household	32/6 to 51/8
Coke	19/– to 22/6
Northumberland—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

Sheffield— Inland.	
Best Hand-picked Branch	25/– to 26/– —
South Yorkshire Best	20/– to 21/– —
Derbyshire Best House	20/– to 21/– —
Derbyshire Best Brights	17,– to 18/– —
Screened House Coal	15/– to 16/– —
Kitchen Coal	14/– to 15/6 —
Best Screened Nuts	15/– to 16/– —
Small Screened Nuts	13/6 to 15/6 —
Yorkshire Hards	16/– to 18/– —
Derbyshire Hards	16/– to 18/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	7/– to 8/6 —
Blast-furnace Coke (Inland)	9/6 to 9/9 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 13/6 to 15/6	

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 25/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	20/–
Pitwood (ex ship)	23/– to 23/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/– to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	11/– to 11/9
Steam Coals:	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6: Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Canalising the Rhone.

The scheme for canalising the Rhône has made a first step towards its ultimate realisation by the formation of the Compagnie Nationale du Rhône, and as the Marseilles Chamber of Commerce is one of the prime movers in this undertaking, it is making every effort to start upon the work without delay. Marseilles looks upon the Rhône as the great waterway for traffic between the Mediterranean and Central Europe, and it hopes to secure the collaboration of Switzerland, which would thus have access to the sea, both by the Rhine and the Rhône. The difficulties of the task are not under-estimated, for the Rhône is a rapid river and many locks would have to be made and the water level raised. This work would effect the level of the Lake of Geneva, to which the Swiss have a strong objection. From the French point of view the undertaking would provide a hydro-electric supply that, it is optimistically estimated, would reduce the country's coal requirements by nearly 10 million tons a year. On the other hand, the cost is believed to be considerably under-estimated, and on account of technical difficulties the Marseilles Chamber of Commerce has always been in favour of constructing a lateral canal for the greater part of the distance. The construction of the Rove tunnel and the canal to Arles was undertaken in anticipation of the Rhône being made navigable for big barges, and the Chamber of Commerce is now insisting that the Compagnie Nationale du Rhône should be allowed to start immediately upon regularising the river between Arles and Lyons, pending the completion of plans for the remainder of the scheme, preferably by means of a lateral canal.

Foreign Trade Relations.

The Conseil National Economique is a State organisation composed of experts and representatives of commercial, industrial and other interests, and its object is to investigate and report upon all economic questions affecting the national prosperity. It has just issued a report upon the way in which high tariffs and import quotas have influenced the general situation. It affirms that there can be no return to normal commercial exchanges, except by a suppression of the existing "closed economic system." The quotas are recognised as having been necessary as a temporary expedient, but it is very difficult to apply them equitably, while, too often, they have the result of benefiting individual interests at the expense of the community. Other bodies have similarly recommended a change of policy which will give a wider scope to foreign trade, and although few go to the length of suggesting the suppression of import duties and quotas, for without them the agricultural industry could not exist, there is, nevertheless, a feeling that an exaggerated system of protection has done incalculable harm, and that a more liberal policy will have to be adopted in the negotiations to be carried out for treaties of commerce. On the other hand, the manufacturing industries cannot bring themselves to relinquish the maximum protection they can get, for which purpose some of them, particularly agricultural engineers, are clamouring for higher import duties and an extension of quotas, so that, while opinion generally is favourable to a more pliable fiscal system which will allow of advantages being accorded to foreign manufacturers in return for concessions, there continues to be strong opposition from some manufacturing industries which are unable to exist in face of foreign competition.

Russian Trade.

The idea of trading with Russia has so far been regarded as illusory and dependent upon arrangements with the Soviet Government for the settlement of pre-war debts; but the unsatisfactory state of the engineering trades seems to be modifying that view, in the sense that it may be undesirable to refuse orders because the guarantees for payment are not all that they should be. It is found that the engineering industries in Germany are kept employed mainly on work for Russia. The credits allowed by Germany to the Soviet Government are considerable, and represent about two-thirds of the total foreign credits; but it is pointed out that notwithstanding the risk incurred, German manufacturers are provided with employment, which is, after all, something to be thankful for. If the Soviet Government pays at the end of the year the huge amount which will then be due to Germany for the supply of manufactured goods, there will be more confidence in the stability of Russian trade. Meanwhile, though desiring to get as much business as they can from Russia, the French will not take undue risks in an attempt to secure Russian orders.

Atmospheric Condensers.

The problem of procuring supplies of water in Africa is often so serious that the congresses held for some years past to discuss it have given a good deal of attention to methods of condensing moisture from the atmosphere in hot and arid countries, and several installations have been laid down on a principle which is known to have been adopted in antiquity. The hot air is admitted through apertures in a large chamber with thick walls, and the moisture condensing inside flows to a well at the bottom. Modern installations are of a more elaborate character, and one has recently been constructed by a Belgian engineer, Monsieur Knapen, at Trans-en-Provence, in the South of France, in the form of a concrete dome of sufficient thickness to insulate the interior from the outside temperature. Inside, slates slant from the walls to provide the greatest possible condensing surface. An 18in. tube projects from the top and is suspended to within about 14in. of the well. Usually, there is only sufficient moisture in the atmosphere for condensation in the early part of the day, and the quantity of water obtained, though relatively small, is held to justify the cost of constructing these condensers in regions where there is no other water supply.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

377,127. February 20th, 1932.—Turbine-condenser Units, Schneider et Cie., 42, Rue D'Anjou, Paris, France.

The invention concerns a steam turbine, a speed-reducing gear, and the necessary condenser, all embodied as one unit, where the condenser is used, more or less, in the sense of a foundation for the set. The horizontal condenser is, consequently, so

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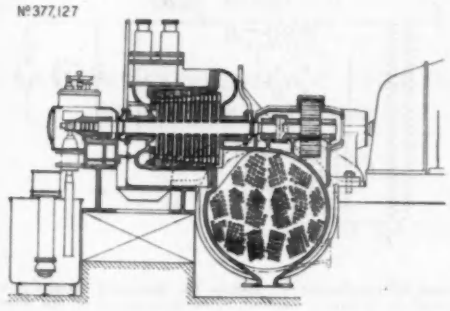

arranged that its nest of tubes, extending transversely relatively to the turbine axis, has its highest tubes below the axis, but in the immediate vicinity of, or slightly above, the lowest point of the last stage of the turbine. This arrangement permits the exhaust to open directly into the condenser casing without any connecting pipe, while permitting the condenser casing to be used as support for the turbine, and also for the speed reducer. In addition, the entire unit is accessible from one common floor. —*July 21st*, 1932.

INTERNAL COMBUSTION ENGINES.

377,133. March 7th, 1932.—Spring Washers for Valves, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

The invention consists in the employment of a valve stem having a reduced portion which is tapered in conjunction with a collar having the inside wall also tapered. This arrangement has the advantage that the bearing surfaces between the valve stem and the slotted collar can be made greater (the

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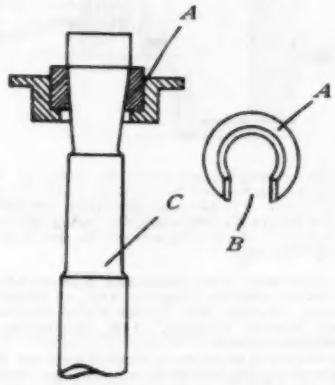

diameter of the stem remaining the same) than when the reduced portion of the stem is of cylindrical shape. The two tapered surfaces fit more snugly, thereby preventing a vibration of the collar on the stem, and enabling the valve to operate with less noise than in the case of the known construction. The collar A has an opening B, which corresponds with the smaller diameter of the conical part of the valve stem C, over which it is slipped to get it in place. It is then pushed up on to the larger part of the cone, where it embraces more than half the circumferences. The collar is then prevented from dropping out sideways.—*July 21st*, 1932.

DYNAMOS AND MOTORS.

376,891. May 18th, 1931.—Brush-holders for Dynamo-electric Machines, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Robert Orsettich, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

This invention relates to brush-holders for dynamo-electric

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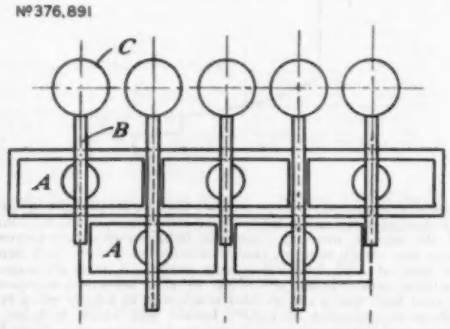

machines. If a large and wide brush is used it is found that an unsatisfactory contact between the brush and the rotary part is obtained, since the contact is restricted to a small portion of the arc over which contact should occur. Moreover, owing to mechanical vibration the line or zone of contact oscillates. The chief object of the invention is to overcome these difficulties in a simple manner, and to provide satisfactory brushgear. As shown, there are two rows of boxes containing brushes A, one row consisting of three boxes and the other row of two boxes. The boxes are staggered as shown. The means for pressing the brushes on to the commutator may be of any suitable form, but are shown diagrammatically as spring fingers B, which may be provided with known means C for separately adjusting the pressures exerted on the different brushes. The brush-holder is supported by an arm, which may also serve to carry the spring fingers B and the adjusting means C. It will be seen that the spacing of adjacent fingers B and pressure adjusting means C is slightly greater than half the lateral dimension of a brush. There is, therefore, ample room for effecting the necessary adjustments in connection with the individual brushes. The boxes may be formed as separate boxes, and then secured together or secured individually to the supporting arm, but preferably all the boxes are formed in one.—*July 21st*, 1932.

376,267. April 1st, 1931.—Fabricated Stator and like Frames for Dynamo-electric Machinery, The English Electric Company, Ltd., of 28, Kingsway, London, W.C.2, and Ernst Heinrich Hermann Hassler, of Siemens Works, Stafford.

This specification describes a special method of constructing fabricated stator frames for electrical machinery. One end of the frame A extends radially to overlap the laminations B. The other frame C has an opening which has a diameter larger than that of the laminations and into which fits the clamping ring D. The frame C and the clamping ring D are provided with holes E at their junction and inclined to the frame axis. The axes of these holes preferably all lie on the surface of a cone and meet at its apex, which lies on the axis of the frame (or machine

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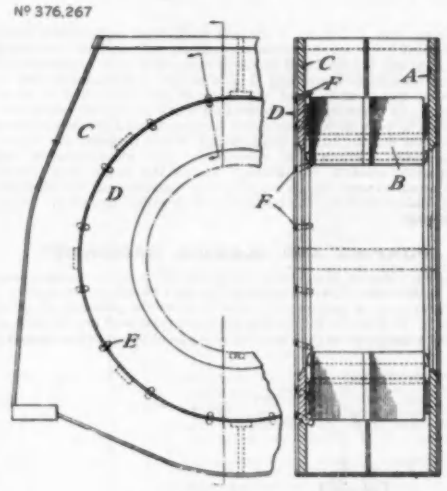

shaft) outside the end plate C. When the core is temporarily clamped with the inner annulus D in position, pegs F are driven through the holes, the inner ends of the pegs clearing the outer edge of the core B. These pegs are then welded to the clamp ring D and to the end plate C around the edges of the holes. Not only is this amount of welding very small, but when the temporary clamping is removed the strain due to the reaction of the laminations is taken by the slanting pegs. The pegs have their ends tapered to facilitate their insertion in the holes. A preferred method of making an end plate of the above kind with holes crossing an annular division line and located partly in each portion of the plate, is to drill the holes in a solid plate and then divide the plate, as by flame cutting, along the average pitch circle of the holes, *i.e.*, the pitch circle in the middle of the thickness of the plate.—*July 1st*, 1932.

TRANSMISSION OF POWER.

376,902. May 27th, 1931.—Electric Insulators, Steatite and Porcelain Products, Ltd., of Stourport, Worcester, and Geoffrey Herbert Halton, of Mount Villa, Stourport.

The object of this invention is to provide an insulator with the maximum vertical surface possible and in which the fullest use is made of such rain or wind as strikes it, and incorporating sharp points directed vertically, without in any way adversely affecting the other characteristics. A, B, and C are the grooves in the outer surface, D is the top or cap

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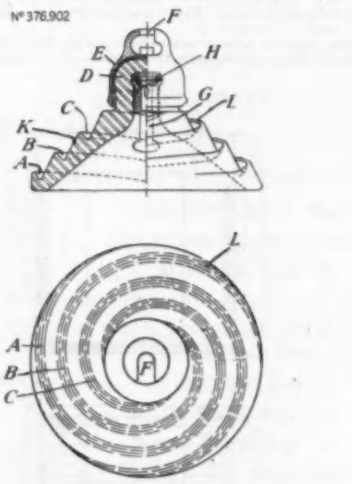

receiving portion of the insulator, E the insulator cap, F the cap recess, G the insulator pin, and H the material for securing the pin in the cap receiving portion D. The grooves A, B, and C pass completely round the insulator more than once. Each of the helical grooves is arranged to extend from the uppermost exposed portion of the conical insulator to its lower edge, and is formed with inclined sides, of which the inner one K extends up to form an outer inclined side of the ridge or wall of the groove

above it, and forms the adjacent turn of the helical groove, with a sharp or pointed ridge-like member L extending in a curved path to the lower edge of the insulator.—*July 21st*, 1932.

376,869. May 1st, 1931.—Apparatus for Deriving Power from High-voltage Lines, *Westinghouse Electric and Manufacturing Company, of East Pittsburgh, Pennsylvania, U.S.A.*

This is a long specification with six illustrations, but, briefly, the idea is to obtain a relatively low-voltage source of power directly from a conductor or conductors of a high-voltage overhead transmission system. In accordance with the scheme shown in Fig. 1, capacitators A, B and C are connected between the line and earth, and across one of the capacitators a local circuit, comprising an inductance D and loads E, is shunted. The

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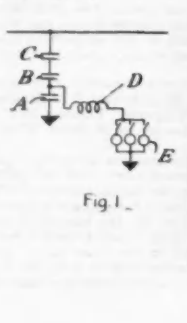

Fig. 1.

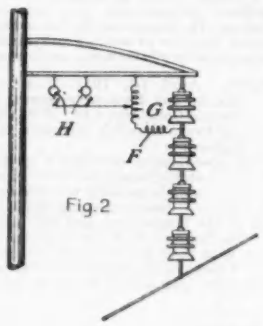

Fig. 2.

drawing, Fig. 2, shows a scheme with four capacitator units connected between the metal supporting pole and the overhead line. Across the first unit a circuit composed of an inductance F and a transformer winding G is shunted. Apparently this is an auto-transformer, and the loads H are connected to it as shown. In some cases, it is stated, it will be found more convenient to provide a transformer for providing a greater current than that flowing in the local circuit, which includes the upper capacitator. When this capacitator and inductance F are resonantly related, the voltage across the loads only varies to a small extent with a considerable variation of the current. The construction of the capacitators is fully described.—*July 21st*, 1932.

PUMPING AND BLOWING MACHINERY.

376,690. March 31st, 1932.—Rotary Pumps, O. Siemen and J. Hinsch, 76, Lindenstrasse, Itzhoe, Holstein, Germany.

This pump is presumably intended for the priming of other pumps. It is of the rotary displacement type, and has an inlet at A and a discharge at B. The discharge passes through the chamber

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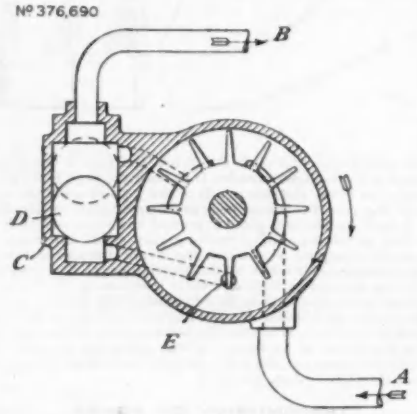

C, in which there is a ball valve D. When the pump is sucking air the static pressure in the delivery is comparatively small and the ball remains at the bottom, clear of its upper seating. Should the pump start to suck water, the delivery pressure will be greatly increased, and this pressure, transmitted through the passage E, will lift the ball valve and close the outlet, so that water is not spilled away.—*July 14th*, 1932.

MISCELLANEOUS.

376,965. July 27th, 1931.—Electrical Condensers, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The object of this invention is to carry off the heat generated in an electrical condenser. The container is filled with an insulat-

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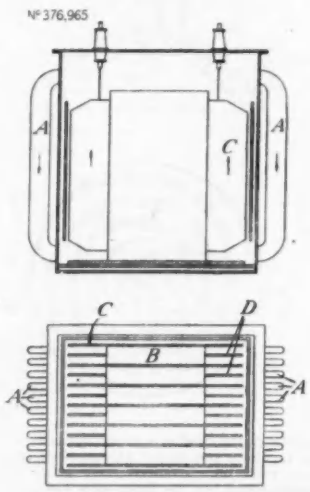

ing cooling medium in the same way as a transformer, and tubes A are provided for increasing the cooling surface. The condenser consists of elements B, which are placed in rows side by side between cooling plates C. The individual elements are wound round mandrels D made in the same way as the cooling plates, which are applied against the external metal foil. In this way the heat generated is satisfactorily transmitted over the cooling plates to the cooling medium. The plates C and the winding mandrels are used as connections to the terminals of the condenser. The coatings overlap each other to the extent of several turns, so that a few turns of the first metal foil are first wound upon the winding mandrel in direct contact with each other.—*July 21st*, 1932.

376,861. April 28th, 1931.—Systems of Electrical Regulation, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

The principle of the regulator described in this specification will be understood by assuming that power supply circuit A is connected to a source of alternating current and that the load on circuit B has been increased. This increase in load would ordinarily result in a decrease in voltage across load devices shown on the right as a result of the voltage drop in lines A and

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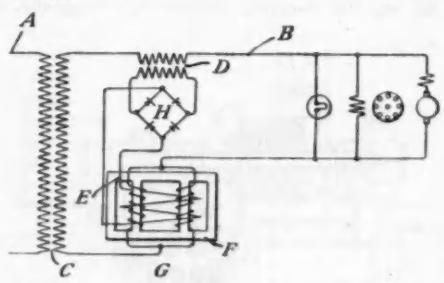

B and in transformer C. But as the increased current flows through the primary winding of the transformer D, the direct current in the saturating winding E increases, thereby increasing the degree of saturation of core F, and decreases the reactance of the reactor G. The decrease in reactance of reactor G is accompanied by a decrease in voltage drop across it, and consequently tends to increase the voltage across the load devices, thus compensating for the voltage drops due to the increased load. It will be understood that the device H is a rectifier.—*July 21st*, 1932.

376,637. December 18th, 1931.—Lubricators, Trier Brothers, Ltd., and B. M. Trier, 36, Victoria-street, Westminster.

This lubricator is a development of the old "Stauffer." It has an auxiliary cylinder in the cap, which is provided with a spring-urged piston. The rod of this piston is hollow and pro-

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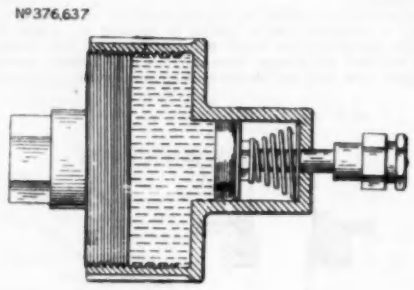
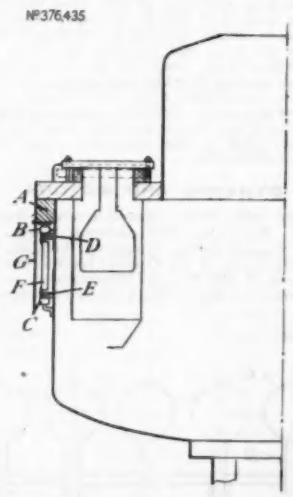


vides a means for pumping grease into the lubricator. When the lubricator has been exhausted the cap is screwed back and is then pumped full again. The fact that it is full is indicated by the protrusion of the piston-rod, while the spring ensures a continuance of grease to the bearing between the periods of screwing down.—*July 14th*, 1932.

376,435. May 26th, 1931.—Mercury Vapour Rectifiers, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and Enrico Gallizia, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

When a rectifier is operating in a cold station and the load is liable to increase rapidly from a zero or small value, the amount of

Nº 376,435



mercury vapour within the rectifier may be insufficient to carry the current of the oncoming load. Furthermore, owing to cooling of the anodes, mercury vapour is liable to condense thereon, with the result that on the occurrence of a large and rapid increase of load back-firing may occur. A mercury vapour rectifier arrangement according to this invention comprises a local load which the rectifier is adapted to supply when it is otherwise unloaded or lightly loaded and which includes or consists of heating means external to, but arranged to heat the rectifier vessel. Generally, the heating means are arranged to heat the vessel in the vicinity of the anode, and in one arrangement the means are adapted to heat the top plate and the part of the tank adjacent to the main anodes of the rectifier. To the underside of the flange A a number of insulators B and C are secured and support bus-bars D and E. Between these bus-bars there are a number of heating elements F. The elements and bus-bars are covered by a guard G, composed of thermally insulating material. The bus-bars are connected for energisation by D.C. supplied by the rectifier. The bars are energised and de-energised by a contactor, the coil of which is controlled by a current relay responsive to the current output of the rectifier and arranged so that when the current falls to a predetermined low value the relay closes its contacts, whereby the contactor coil is energised and closure of the contactor brings the heating elements into operation. In this way a load is maintained on the rectifier which operates internally through the arc and externally through the heating elements to maintain the rectifier at a suitable temperature.—*July 14th*, 1932.

376,684. March 10th, 1932.—Apparatus for Mixing Fluids and Solids, *W. W. Triggs, 57, Lincoln's Inn Fields, London, W.C. 2.*

This machine is intended for the thorough mixing of liquids and solids in chemical and other processes, where there is a tendency for the heavy solids to drop out of suspension in the

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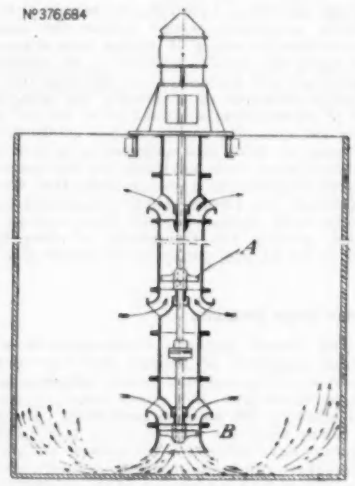

liquid and to form a cake in the bottom of the container. The stirring is effected by the main screw pump A, which circulates the fluid as shown by the arrows. A second pump B on an extension of the main spindle causes a violent circulation in the base of the container and prevents the deposition of the solids.—*July 14th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY TO MONDAY, SEPTEMBER 19TH.

Institution of Mechanical Engineers.—Summer visit to Canada.

SATURDAY, AUGUST 20TH.

Institution of Municipal and County Engineers.—North Wales District meeting at Penmaenmawr. Meet at Penmaenbach works, Penmaenmawr. 2.15 p.m.

North of England Institute of Mining and Mechanical Engineers.—In the Lecture Theatre of the Institute, Newcastle-upon-Tyne. Annual general meeting. 2.30 p.m.

TUESDAY TO SATURDAY, AUGUST 30TH TO SEPTEMBER 3RD.

Institut International de Documentation.—Frankfurt-am-Main. Eleventh conference. For details see page 148.

WEDNESDAY, AUGUST 31ST, TO WEDNESDAY, SEPTEMBER 7TH.

British Association for the Advancement of Science.—Annual meeting at York. President, Sir J. Alfred Ewing, F.R.S. Particulars may be obtained on application to the secretary, British Association, or to the hon. local secretaries, British Association, The Guildhall, York.

SATURDAY, SEPTEMBER 10TH.

Institution of Municipal and County Engineers.—Eastern District meeting to be held at Great Yarmouth. Assemble at Town Hall, Great Yarmouth, 10.30 a.m.

MONDAY, SEPTEMBER 12TH.

Institute of Metals.—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual autumn lecture, "Corrosion Fatigue in Metals," by Dr. H. J. Gough. 8 p.m.

MONDAY TO THURSDAY, SEPTEMBER 12TH TO 15TH.

Iron and Steel Institute and Institute of Metals.—Joint autumn meeting in London. For programme see page 119.

TUESDAY TO SATURDAY, SEPTEMBER 13TH TO 17TH.

International Foundry Congress.—Paris.

SATURDAY, SEPTEMBER 24TH.

All-British Exhibition.—Copenhagen, Denmark, Opening.